

OK

STUDENT GUIDE
for
COMMUNICATIONS SYSTEMS
(PRELIMINARY)

PREPARED BY
ELECTRONICS TECHNICIAN "A" SCHOOL
NAVAL SCHOOL COMMAND
TREASURE ISLAND, CALIFORNIA
OCTOBER 1970

Reviewed and Approved

R. G. Teal

LT. R. G. TEAL
16 October 1970

INTRODUCTION

SAFETY:

Extreme danger of personal injury or damage to equipment is present when power is applied to electronics equipment. It is imperative that all safety precautions and warnings given in the technical manuals be followed when performing the procedures given on the job sheets. The safety requirements of Naval Ships Technical Manuals, Chapter 9670, should be observed.

HOW TO USE THIS STUDENT GUIDE:

This student guide does not supersede any existing publication. Rather it supplements the information contained in various Naval Publications. The primary purpose of this guide is to provide self-study material that requires a minimum of supervision.

This guide contains information sheets, assignment sheets, and job sheets for each of the two topics (operation and maintenance). As a general rule, your instructor will assign a given number of assignment sheets for you to complete for the following day which will then be followed-up by your performing the corresponding job sheets.

TABLE OF CONTENTS

	PAGE
INTRODUCTION	i
LEARNING OBJECTIVES	
TOPIC I, OPERATIONAL TECHNIQUES	1
TOPIC II, MAINTENANCE TECHNIQUES	4
INFORMATION SHEETS	
4-1-1I INTRODUCTION TO COMM SYSTEMS	6
4-1-2I GLOSSARY OF TERMS	9
4-1-3I HF CW TELEGRAPHY COMM SYSTEM	11
4-1-4I HF SSB TELEPHONY COMM SYSTEM	17
4-1-5I UHF DSB AM TELEPHONY COMM SYSTEM	24
4-1-6I UHF-TO-HF VOX RELAY COMM SYSTEM	26
4-1-7I HF SSB AFTS RATT COMM SYSTEM	32
4-1-8I HF SSB MULTI-CHANNEL RATT COMM SYSTEM	38
4-1-9I UHF AFTS RATT COMM SYSTEM	41
4-1-10I HF SSB AFTS MULTI-CHANNEL (SIMULATED SECURE) RATT COMM SYSTEM	45
4-2-1I SYSTEM BLUEPRINTS	48
4-2-2I SYSTEM MAINTENANCE	54
ASSIGNMENT SHEETS	
4-1-1A HF CW TELEGRAPHY COMM SYSTEM	62
4-1-2A HF SSB TELEPHONY COMM SYSTEM	65
4-1-3A UHF DSB AM TELEPHONY COMM SYSTEM	67
4-1-4A UHF TO HF VOX RELAY COMM SYSTEM	68
4-1-5A HF SSB AFTS RATT COMM SYSTEM	69
4-1-6A HF SSB AFTS MULTI-CHANNEL RATT COMM SYSTEM	72
4-1-7A UHF AFTS RATT COMM SYSTEM	75
4-2-1A SYSTEM BLUEPRINTS	78
4-2-2A SYSTEMS MAINTENANCE	79
JOB SHEETS	
4-1-1J HF CW TELEGRAPHY COMM SYSTEM	82
4-1-2J HF SSB TELEPHONY COMM SYSTEM	84
4-1-3J UHF DSB AM TELEPHONY COMM SYSTEM	86
4-1-4J UHF TO HF VOX RELAY COMM SYSTEM	88
4-1-5J HF SSB AFTS RATT COMM SYSTEM	90
4-1-6J HF SSB AFTS MULTI-CHANNEL RATT COMM SYSTEM	93
4-1-7J UHF DSB AFTS RATT COMM SYSTEM	97
4-1-8J HF SSB AFTS MULTI-CHANNEL (SIMULATED SECURE) COMM SYSTEM	99
4-2-1J SYSTEM READINESS TESTS	103

SHIPBOARD EQUIPMENT INDOCTRINATION

SECTION: 4 COMMUNICATION SYSTEMS
TOPIC: 1 OPERATIONAL TECHNIQUES

A. OBJECTIVES:

1. When the student completes this topic, he will be able to:
 - a. SET-UP a communications system to perform each operation listed below in accordance with pre-established Communications Plan specifications by TUNING and ADJUSTING the prescribed equipment for proper operation as outlined in applicable Technical Manuals, COMPLETING all required interconnections as indicated on an appropriate block diagram, CONDUCTING communication checks with other compatible systems, and observing all safety precautions.
 - (1) Simplex HF CW Manual Morse Telegraphy using the following type of equipment:
 - (a) Receive Antenna Filter/Patch Assembly
 - (b) HF Receiver
 - (c) Receiver Jack Box
 - (d) CW Key Panel
 - (e) Transmitter Transfer Switchboard
 - (f) HF Transmitter
 - (g) Transmit Antenna Coupler Group
 - (2) Simplex HF SSB Telephony using the following type of equipment:
 - (a) Receive Antenna Filter/Patch Assembly
 - (b) HF SSB Transceiver
 - (c) Receiver Transfer Switchboard
 - (d) Speaker Amplifier
 - (e) Remote Phone Unit
 - (f) Transmitter Transfer Switchboard
 - (g) Transmit Antenna Coupler Group
 - (3) Simplex UHF DSB AM Telephony using the following type of equipment:
 - (a) UHF Transceiver
 - (b) Receiver Transfer Switchboard
 - (c) Speaker Amplifier
 - (d) Remote Phone Unit
 - (e) Transmitter Transfer Switchboard

- (4) Simplex VOX Relay by conversion of UHF DSB AM Telephony to HF SSB Telephony, using the following type of equipment:
- (a) UHF Receiver
 - (b) Receiver Transfer Switchboard
 - (c) VOX Relay Control Unit
 - (d) Transmitter Transfer Switchboard
 - (e) HF SSB Transmitter
 - (f) Transmit Antenna Coupler Group
- (5) Half-Duplex HF SSB AFTS RATT using the following type of equipment:
- (a) Receive Antenna Filter/Patch Assembly
 - (b) HF SSB Receiver
 - (c) Receiver Transfer Switchboard
 - (d) Converter/Comparator Group
 - (e) DC Power Supply
 - (f) Teletype Patch Panel
 - (g) Teletype Machine
 - (h) Transmitter Control Unit
 - (i) Transmitter Transfer Switchboard
 - (j) HF SSB Transmitter
 - (k) Transmit Antenna Coupler Group
- (6) Full-Duplex HF SSB AFTS RATT using the following type of equipment:
- (a) Receive Antenna Filter/Patch Assembly
 - (b) HF SSB Receiver
 - (c) Receiver Transfer Switchboard
 - (d) Telegraph Terminal Set (Multi-Channel)
 - (e) DC Power Supply
 - (f) Teletype Patch Panel
 - (g) Red/Black Switch (Simulator)
 - (h) Teletype Machine
 - (i) Transmitter Control Unit
 - (j) Transmitter Transfer Switchboard
 - (k) HF SSB Transmitter
 - (l) Transmit Antenna Coupler Group
 - (m) Frequency Standard
 - (n) Frequency Standard Patch Panel

(7) Half-Duplex UHF DSB AFTS RATT using the following type of equipment:

- (a) UHF Transceiver
- (b) Receiver Transfer Switchboard
- (c) Tone Terminal Set (Single-Channel)
- (d) DC Power Supply
- (e) Teletype Patch Panel
- (f) Teletype Machine
- (g) Transmitter Control Unit
- (h) Transmitter Transfer Switchboard

(8) Full-Duplex HF SSB AFTS (Simulated Secure) RATT using the following type of equipment:

- (a) Receiver Antenna Filter/Patch Assembly
- (b) HF SSB Receiver
- (c) Receiver Transfer Switchboard
- (d) Telegraph Terminal Set (Multi-Channel)
- (e) DC Power Supply
- (f) Teletype Patch Panel (Non-Secure)
- (g) Encoder/Decoder (Simulator)
- (h) Secure Power Supply (Simulator)
- (i) Teletype Patch Panel (Secure)
- (j) Red/Black Switch (Simulator)
- (k) Teletype Machine
- (l) Transmitter Control Unit
- (m) Transmitter Transfer Switchboard
- (n) HF SSB Transmitter
- (o) Transmit Antenna Coupler Group
- (p) Frequency Standard
- (q) Frequency Standard Patch Panel

SHIPBOARD EQUIPMENT INDOCTRINATION

SECTION: 4 COMMUNICATIONS SYSTEMS

TOPIC: 2 MAINTENANCE TECHNIQUES

A. OBJECTIVES:

1. When the student completes this topic, he will be able to:
 - a. DEMONSTRATE his ability to read and interpret typical shipboard electronics systems blueprints by:
 - (1) SELECTING the correct blueprint for a given maintenance task when provided with several prints to choose from.
 - (2) TRACING the interconnections for any given system after selecting the correct blueprint.
 - (3) TRANSLATING blueprint legends and cable markings to determine the following information when provided with the procedures and tables contained in NAVSHIPS 0967-000-0140.
 - (a) Cable function
 - (b) Cable type and size
 - b. PERFORM assigned Systems Readiness Tests (SRT's) to determine the operational status of the systems listed below, following procedures outlined on applicable Maintenance Requirement Cards (MRC) and observing all safety precautions.
 - (1) MF/HF Transmitting Systems
 - (2) MF/HF Receiving Systems
 - (3) UHF/VHF Communications Systems
 - (4) Communications Remote Systems
 - (5) Radio Teletype Systems
 - c. ISOLATE and CORRECT the following types of malfunctions within a given system utilizing a logical troubleshooting procedure, appropriate test equipment, technical manuals and/or blueprints, and observing all safety precautions.
 - (1) Improperly set-up interconnections
 - (2) Improperly adjusted equipment
 - (3) Defective interconnections
 - (4) Defective equipment

- d. DOCUMENT maintenance action in accordance with procedures outlined in OPNAV 43P2 when provided with appropriate Maintenance Data Collection System (MDCS) Forms.

INTRODUCTION TO COMMUNICATION SYSTEMS

A. INTRODUCTION:

1. This information sheet briefly describes shipboard communication systems in terms of what they are and how they are used.

B. REFERENCE:

1. NAVSHIPS 0901-670-0002, NAVAL SHIPS TECHNICAL MANUAL-CHAPTER 9670.

C. INFORMATION:

1. Naval communications has, in this modern day and age, become a highly sophisticated and exacting field of electronics. Even comparatively small ships must have the capabilities for coming up on the more commonly used ship-to-ship, ship-to-air, and ship-to-shore communication circuits. Such circuit operations are accomplished through the use of compatible communication systems by each of the ships and/or other activities involved.
2. A communication system may be generally defined as a group of units, equipments, and sub-systems, each having its own separate identity, and arranged and interconnected to perform a circuit operation that cannot be performed by the individual units alone.
3. Communication systems vary from simple to complex depending, for the most part, on the type of circuit operation involved. Each system requires the integrated use of certain types of equipment. Thus, it can be seen that a large number of equipments may be involved when several systems must be separately and simultaneously supported.

The concept of shipboard efficiency not only dictates where given types of communications equipment should be physically located, but also that they be installed in a manner permitting flexibility for different system applications. Such flexibility is afforded through a complex arrangement of interconnections which allows the physically separated units, equipments, and sub-systems to be selectively switched and/or patched into different system configurations.

An example of such an interconnected equipment complex is shown in Figure 1. While only a small complex is represented on the diagram, there is a sufficient variety of equipment included to hypothetically set up and support several different types of system operations. Some of these are individually described by other information sheets in this Student Guide.

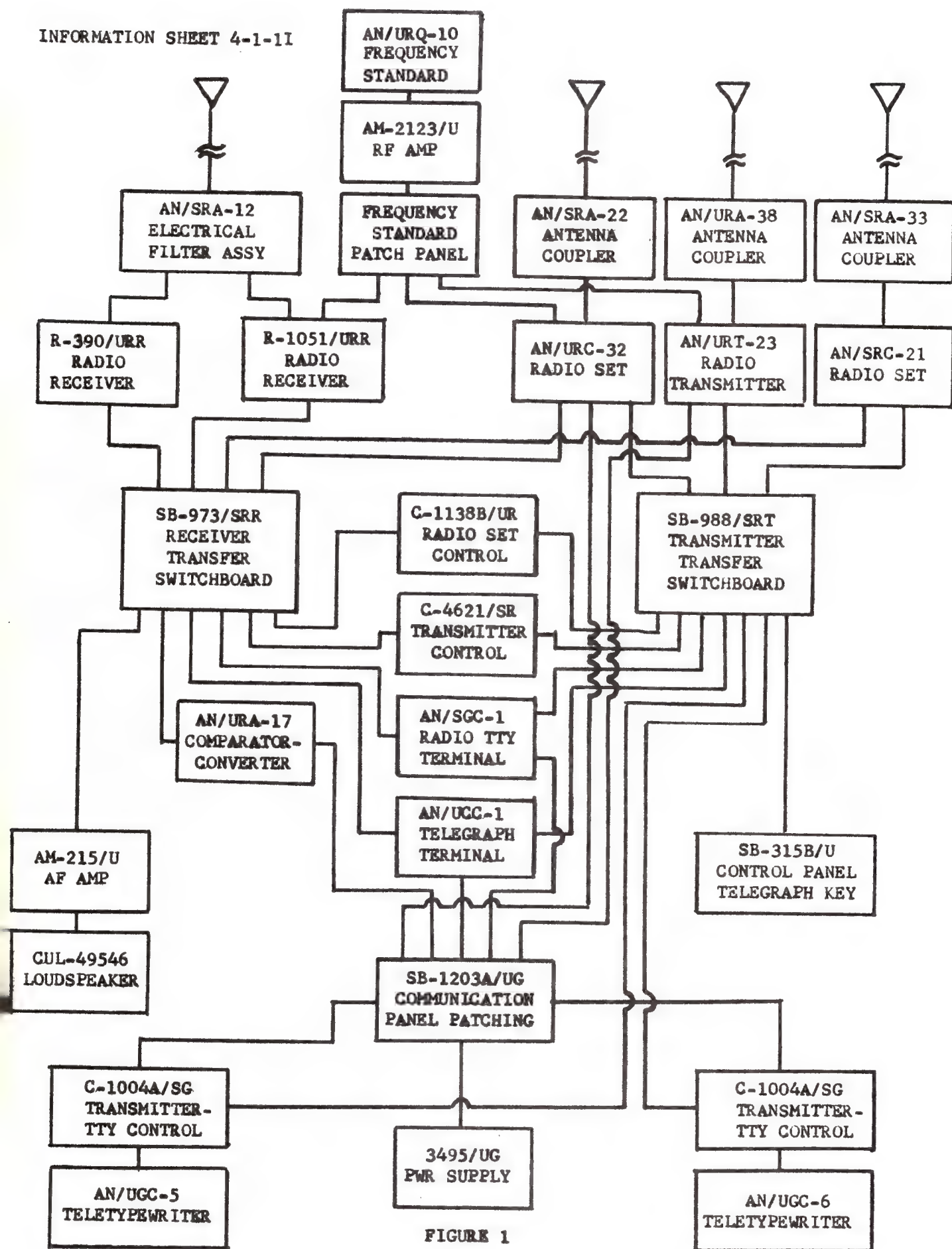


FIGURE 1

4. Most shipboard communications equipment is, at one time or another, involved in one or more different system operations. It is, therefore, just as important for the technician to know how to perform maintenance at a systems level as it is on the individual equipments. Not only must he be able to locate and correct malfunctions within a given system, but he must also be able to rectify problems caused by a lack of RF Compatibility (operational harmony) between different systems.

In order to accomplish these maintenance responsibilities, it is of the utmost importance that the technician know how different types of communication systems function and how they are properly set up for compatible operation.

GLOSSARY OF TERMS

A. INTRODUCTION:

1. The purpose of this information sheet is to provide you with a reference of definitions for terms that are new to you and terms that are familiar but used in a new context.

B. REFERENCES:

1. Cooke and Markus, ELECTRONICS AND NUCLEONICS DICTIONARY.
2. NAVSHIPS 0967-307-7010, SINGLE SIDEBAND COMMUNICATIONS.
3. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK.

C. INFORMATION:

1. AFTS: An abbreviation for Audio Frequency Tone Shift used to describe a type of RATT system. Commonly referred to in the past as Tone Modulated RATT, VFTG RATT, SSB RATT and Audio Frequency Shift Keying.
2. CIRCUIT: A complete wire, radio, or other carrier communications channel.
3. EMI: An abbreviation for Electromagnetic Interference which is defined as any undesired radiated or conducted electrical perturbation which degrades the proper operation of electrical or electronic equipment.
4. FULL-DUPLEX OPERATION: Operation of telegraph or other signal systems in opposite directions simultaneously.
5. HALF-DUPLEX OPERATION: Operation of a telegraph system in either direction over a single channel, but not in both directions simultaneously.
6. LOP: An abbreviation for Local Operator Position.
7. LRS: An abbreviation for Local Radio Station.
8. LTP: An abbreviation for Local Teletype Position.
9. MULTIPLEX OPERATION: The simultaneous transmission, or reception, of two or more programs or signals over a single RF channel by methods such as time division, frequency division, or phase division.

INFORMATION SHEET 4-1-2I

10. NET: A number of communication stations equipped for communication with each other, often on a definite time schedule and in a definite sequence.
11. RATT: An abbreviation for Radio Teletype.
12. RF COMPATIBILITY: A term that refers to the degree of operational harmony existing within and/or between systems that are used for the transmission and/or reception of radio emissions.
13. RFCS: An abbreviation for Radio Frequency Carrier Shift used to describe a type of RATT system. Sometimes referred to as the older type of FSK when compared to AFTS.
14. SIMPLEX OPERATION: A method of radio operation in which communication takes place between two stations in only one direction at a time. This includes ordinary transmit-receive operation, press-to-talk operation, voice-operated carrier, and other forms of manual or automatic switching from transmit to receive.
15. SYSTEM: A combination of several pieces of equipment integrated to perform a specific function.
16. TELEGRAPHY: Communication at a distance by means of code signals consisting of current pulses sent over wires or by radio.
17. TELEPHONY: The transmission of speech and sound to a distant point for communication purposes.

HF CW TELEGRAPHY COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This Information Sheet will describe the functional relationship of the equipments used in a typical HF CW Telegraphy Communication System.

B. REFERENCES:

1. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK
2. NAVSHIPS 92206, AN/SRA-12 TECHNICAL MANUAL
3. NAVSHIPS 93122, SB-315/U TECHNICAL MANUAL
4. NAVSHIPS 93516, SB-988/SRT TECHNICAL MANUAL

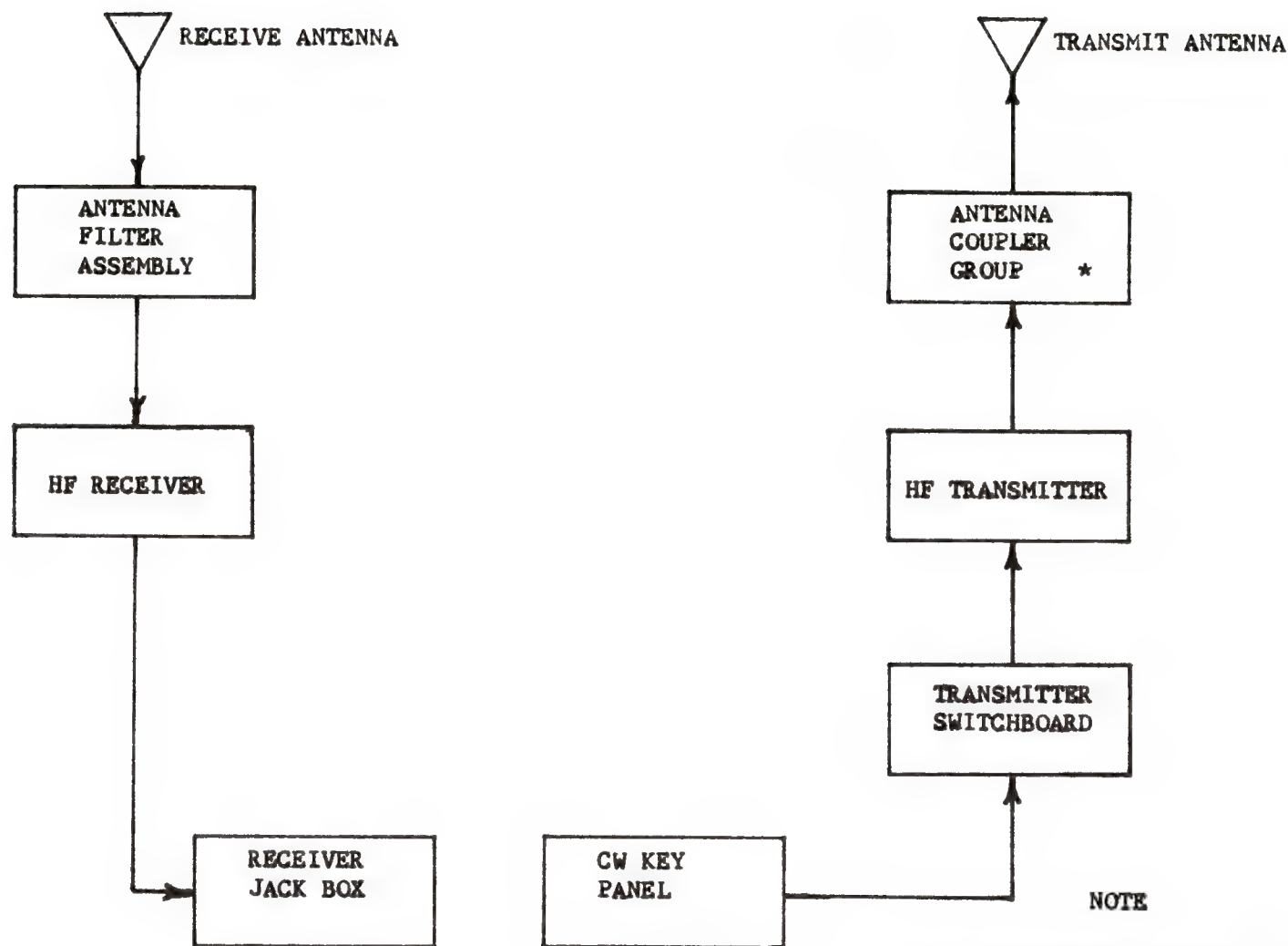
C. INFORMATION:

1. CW Manual Morse Telegraphy is one of the oldest and most reliable forms of radio communications. It is also the least complicated in terms of the system configuration involved. Figure 1 shows that the system is little more than a transmitter and a receiver arranged and interconnected to facilitate their control from a central location.
2. The receiving antenna may be any one of several shipboard types that are suitable for receiving HF emissions. In order that a given antenna may be used with several HF receivers simultaneously, it is patched to an antenna filter assembly such as the AN/SRA-12 or AN/SRA-49.

The specified overall frequency response of an antenna filter assembly, or "multicoupler," is divided into several smaller RF ranges, or channels, through the use of tuned circuits or filter subassemblies. Any or all of these channels may be used independently of, or simultaneously with, any of the other channels.

The filters not only guard against interference at frequencies falling outside the channel being used, but also prevent receivers connected to alternate channels from interacting with each other when their tuning or trimming adjustments are made.

A given Navy communications receiver generally operates throughout a frequency range that spans several of the smaller RF bands, or channels, provided by the multicoupler. For operation on any given frequency, the receiver must be connected to the output of the particular RF channel that will pass the desired signals. Connection is normally made by means of a coaxial patch cord and a patch panel.



* MULTICOUPLER REQUIRED FOR USE OF COMMON ANTENNA BY SEVERAL TRANSMITTERS.

FIGURE 1 HF CW TELEGRAPHY COMMUNICATION SYSTEM

3. An HF receiver with a variable BFO, such as the R-390/URR or R-1051/URR, should be used for reception of CW Telegraphy so that the pitch of the tone output can be adjusted to suit the operator. The receiver should also be physically located at or near the LOP for ease in making this and whatever other tuning adjustments might become necessary. This normally precludes using a remotely located transceiver for reception of CW signals even if it's being used for transmission on the same circuit and frequency.

A combination of high level signals and an excessive RF gain control setting frequently results in the receiver-processed output signals being distorted. This type of distortion is known as receiver overload or saturation and occurs when high level RF signals cause the RF amplifier stages to operate in the non-linear regions of their plate current characteristic curves. In a more critical receiver application, this would be intolerable and require that the RF gain control setting be lowered. For CW Telegraphy, however, the operator normally uses the receiver as a monitor of his own transmissions as well as for reception of the weaker signal from the other station. In this case, the RF gain setting should be sufficient for reception of the weaker signal and AGC incorporated to lower the gain of the receiver while monitoring own-ship transmissions.

The receiver audio output is normally hardwired directly to two other units. One of these is a Receiver Transfer Switchboard, such as the SB-973/SRR, which is an integral component in more complex systems. The other unit is a Receiver Jack Box, such as the J-939/U, and is located at the LOP for the operator to plug his headphones into during reception of CW Telegraphy.

4. The operator also has a CW Key Panel, such as the SB-315/U, located at the LOP. As shown by Figure 2, this unit provides LOP control (on/off and keying) of the transmitter selected on the transmitter transfer switchboard. Located on the plastic control panel of the SB-315/U are (1) a toggle switch for turning the transmitter on or off, (2) an indicator light that glows red when the transmitter is turned on (3) a telegraph key that provides a means for keying the transmitter, and (4) a key jack that provides for an auxilliary telegraph key.

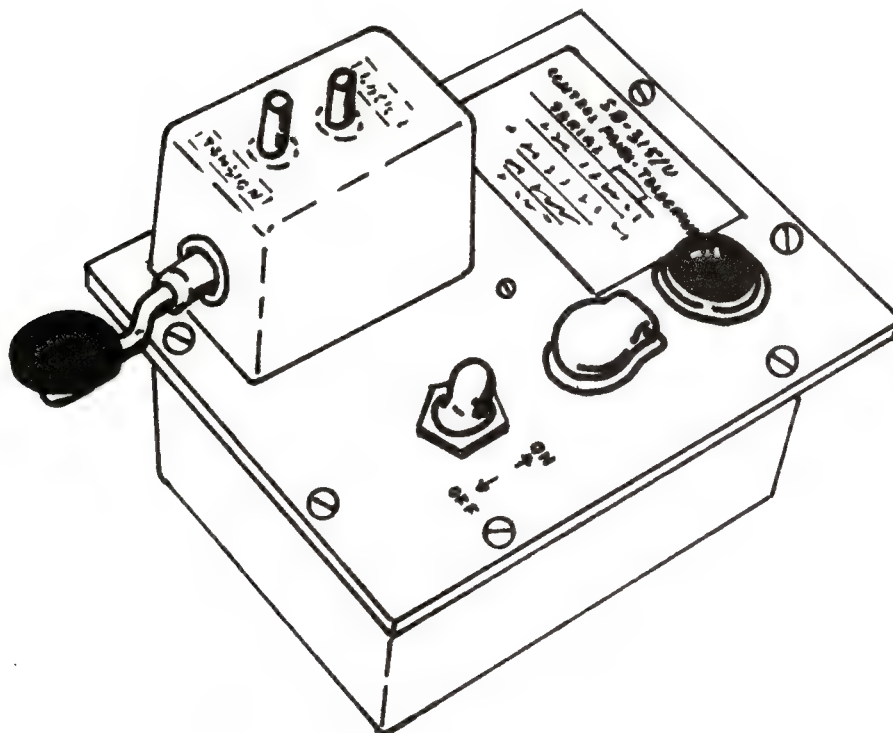
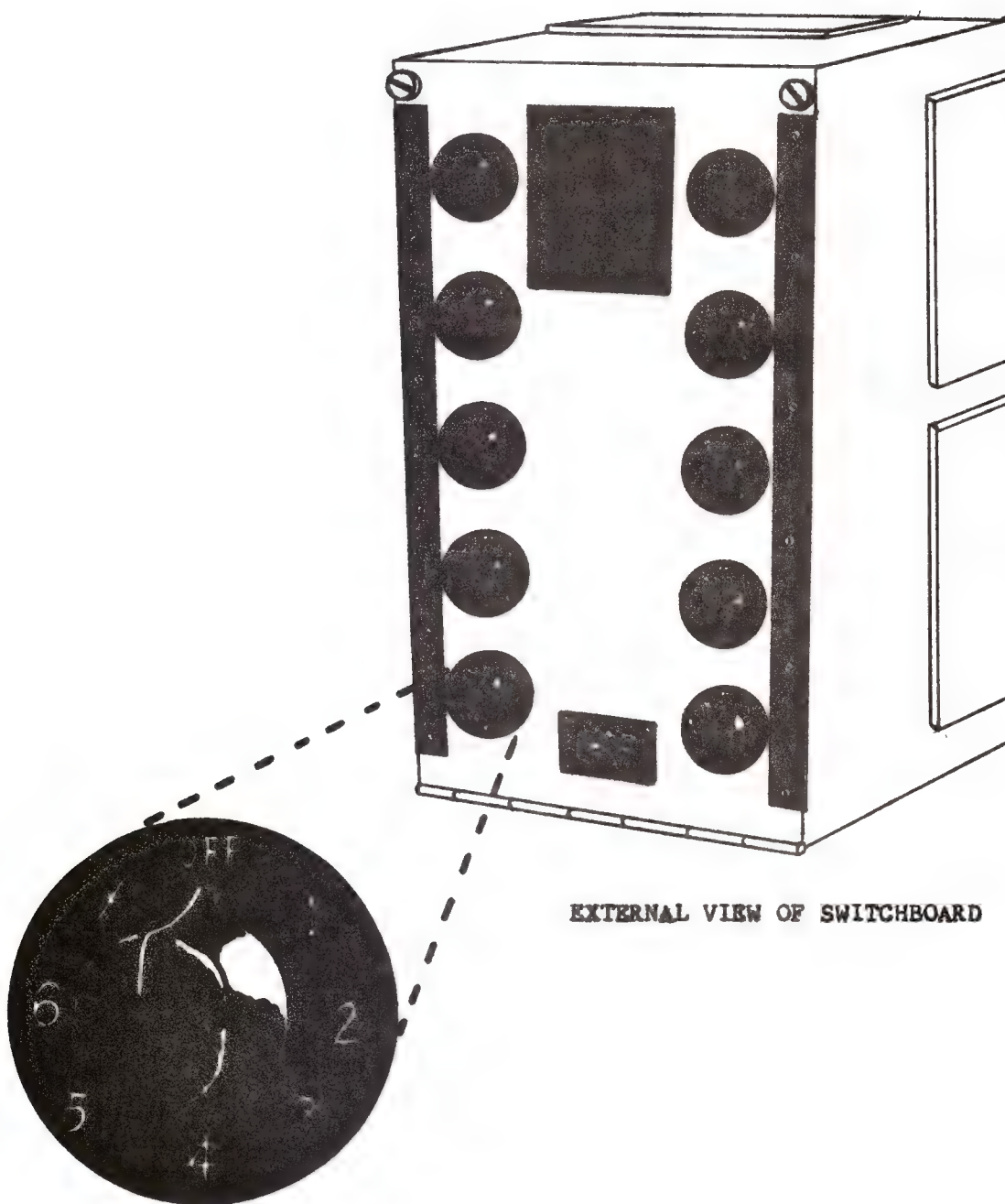


Figure 2. CONTROL PANEL TELEGRAPH KEY SB-315/U

5. The purpose of a Transmitter Transfer Switchboard, such as the SB-988/SRT, is to provide facilities for selectively transferring any one, or all, of ten remote control stations to any one of six transmitters. The cabinet has ten rotary switches, arranged in two vertical rows of five switches each (Figure 3.).

Each switch operating knob corresponds to a remote control station. Each rotary switch position (one through six) corresponds to a controlled transmitter. Rotary position X corresponds to an extension providing for the transfer of all circuits to additional Transmitter Transfer Switchboards when more than ten remote control stations, or when more than six transmitters, are installed in the system.

When it is required, for example, that remote control station number two is to have control of transmitter number three; switch knob designated number two is rotated until its pointer indicates position three on its respective dial plate. Any of the remote stations may thus be connected to control any of the transmitters installed in the system. Arrangement of the circuitry is such that it is impossible to parallel transmitter control circuits.



EXTERNAL VIEW OF SWITCHBOARD

EXPLODED VIEW OF SWITCH

FIGURE 3 SWITCHBOARD, TRANSMITTER TRANSFER SB-988/SRT

6. CW Telegraphy is not considered to be a modulated emission and the transmitter does not receive an audio signal from the LOP. The emission does, however, require a 100Hz bandwidth. This figure is based on the keying rate involved for sending 25 WPM in Morse code. Since the first figures of an emission designator correspond to the bandwidth in KHz, the designator for CW Manual Morse Telegraphy is .1A1.

Certain HF transmitters, such as the AN/URT-23, do not use sideband generation as a means for developing an A1 emission. Consequently, the center of emission is the same as the dialed channel frequency. Other equipment such as the AN/URC-32, do use sideband generation for developing an A1 emission. In this case, the center of emission is above the dialed channel frequency by whatever frequency (1 or 1.5 KHz) is being produced by the CW Tone oscillator. The Comm Plan compensates for this frequency deviation in addition to designating what transmitter will be used.

Transmitters and antenna couplers should always be tuned and adjusted in accordance with procedures outlined in the appropriate technical manuals as an effective way to minimize EMI and enhance quality communications. With regard to RF compatibility, another "rule of thumb" is to adjust the transmitter only for sufficient output power to adequately maintain communications. This policy will lessen EMI to other own-ship transmitters and decrease the possibility of intermodulation products being generated in their output stages.

Only after the transmitter has been locally tuned and adjusted properly should it ever be placed in remote operation. When this has been accomplished, the controls may then be transferred, via the SB-988/SRT Transmitter Transfer Switchboard, to the LOP designated on the Comm Plan.

HF-SSB TELEPHONY COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This information sheet will describe the functional relationship of the equipments used in a typical HF-SSB Telephony Communications System.

B. REFERENCES:

1. NAVSHIPS 91626, AM-215A/U TECHNICAL MANUAL
2. NAVSHIPS 94478, C-1138/U TECHNICAL MANUAL
3. NAVSHIPS 93537, SB-973/SRR TECHNICAL MANUAL
4. NAVSHIPS 0967-307-7010, SSB COMMUNICATIONS
5. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK

C. INFORMATION:

1. HF SSB Telephony is extensively used in the Navy for long range communications. As shown in Figure 1, the system configuration is not, in itself, complicated. However, there are some very important operational and maintenance techniques that must be observed if reliable and high quality communications is to result.
2. In this system, simplex operation is employed which will allow the use of a transceiver as the major equipment group. In most transceivers, one antenna is used for both receive and transmit function. If a particular system installation necessitates the involvement of different receiving and transmitting antennas, separate patching to the receiver will be required at an antenna filter assembly such as the AN/SRA-12 or AN/SRA-49.
3. Degraded communications is often simply the fault of making improper adjustments to the front panel controls of a receiver. The following operational considerations should be kept in mind, when tuning and adjusting a receiver, in order to help achieve high quality communications and RF compatibility.
 - a. FREQUENCY STABILITY: Of all the requirements for high quality SSB communications, frequency stability is the most important. The receiver must be set to exactly the same frequency as that

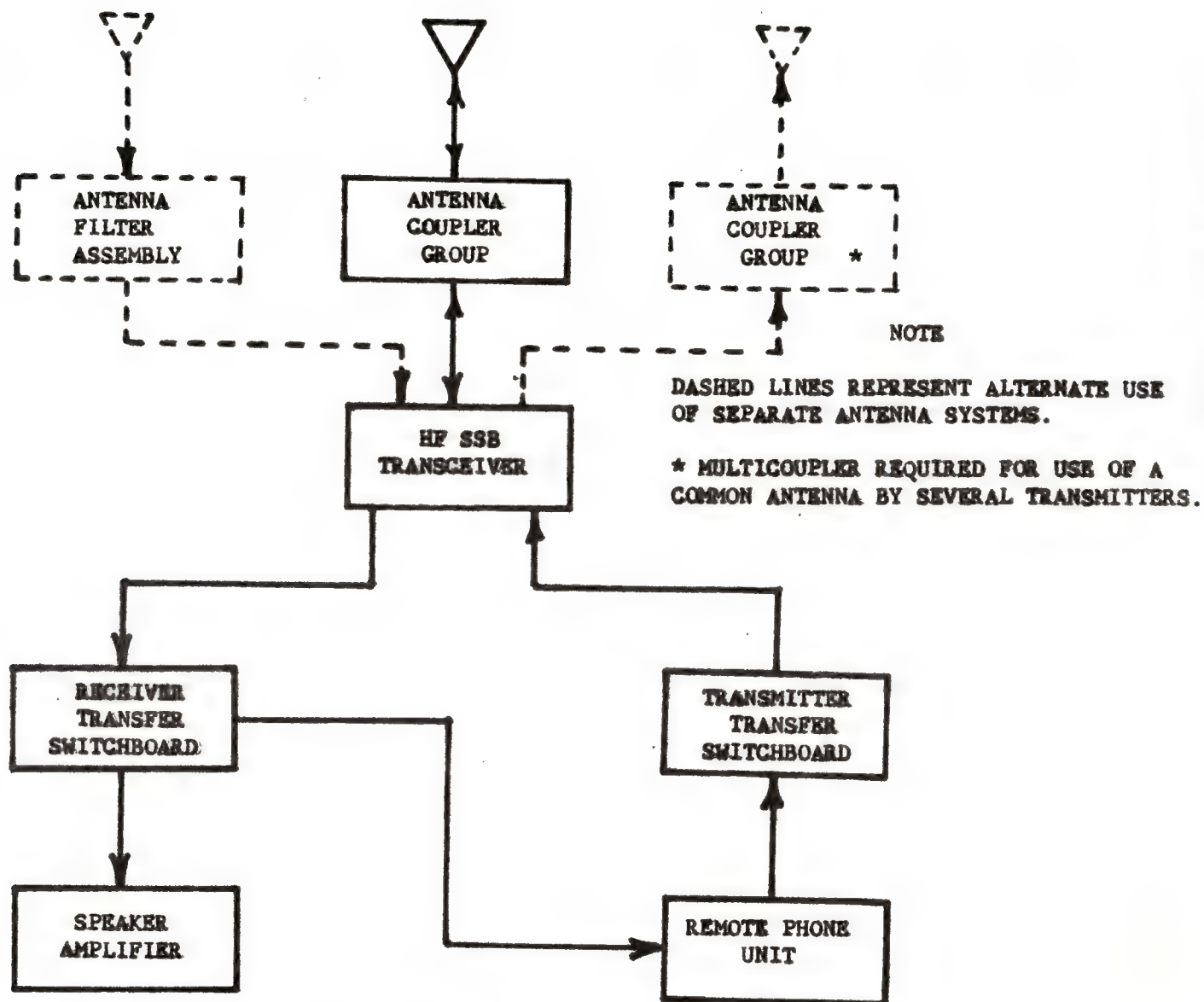


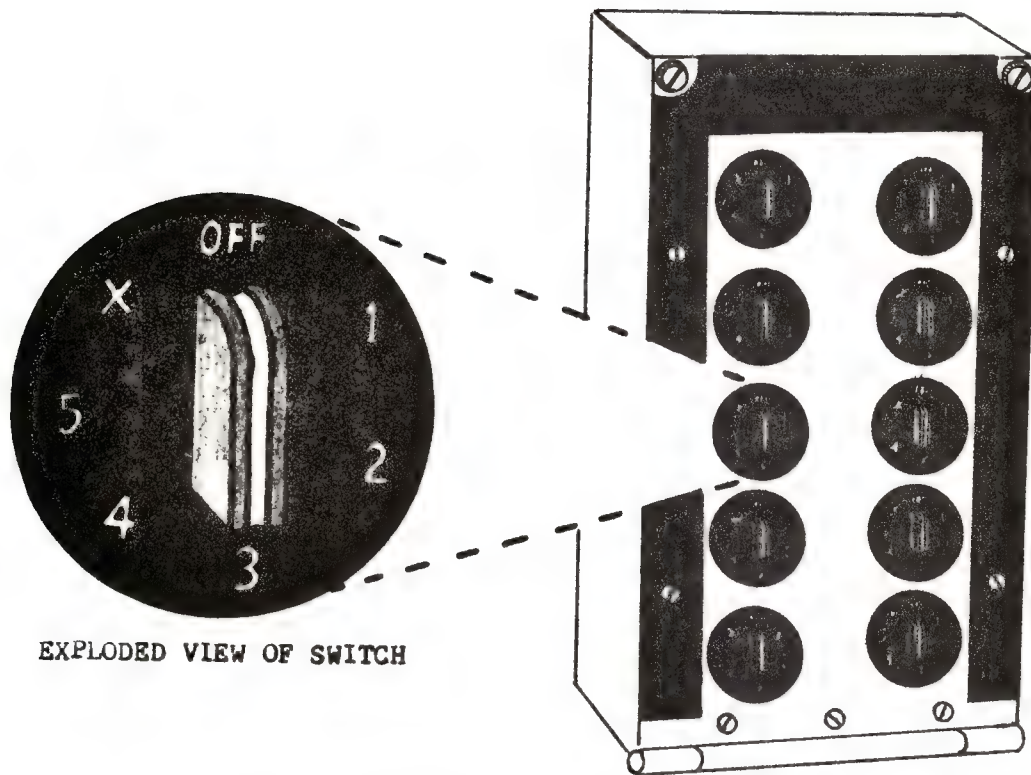
FIGURE 1 HF SSB TELEPHONY COMMUNICATIONS SYSTEM

of the transmitter. Any deviation of this setting will result in degraded communications. It should be obvious that a local oscillator that would drift even the smallest amount would be unacceptable in an SSB receiver. As you will recall from your past studies most SSB equipment uses either a stabilized master oscillator or a frequency synthesizer to accomplish accurate frequency control. All of the output frequencies are derived from one very accurate stable frequency. This very stable frequency is usually referred to as the reference, or standard frequency. In most of the newer equipments used in the Navy, provisions have been included that make it possible to use either the equipments internal standard (with accuracies somewhere around 1 part in 10^8) or to use an external standard such as the AN/URQ-10 which is accurate to 1 part in 10^{10} .

- b. BANDWIDTH: In most receivers the bandwidth of the IF section will be a function of the mode of operation (SSB mode = 3KHz BW, Am mode = 6KHz BW, etc.,) but it is important to mention that in some older receivers bandwidth may be controlled by an external switch.
 - c. GAIN SETTINGS: RF gain control should be set to maximum, except in instances when the input signal is extremely high level. The AGC should always be used when receiving SSB. The audio level should be adjusted for 0 dbm output. This will prevent audio crosstalk on other audio lines.
4. The audio output of the receiver is hardwired to the receiver switchboard SB-973/SRR where it may be switched to any remote operating station.

Receiver Transfer Switchboard, SB-973/SRR, has the purpose of transferring any one of five radio receivers to any one or all of ten remote control stations. Provision is made for connections to additional Receiver Transfer Switchboards, to transfer any number of radio receivers to any number of remote control stations. One additional switchboard is required for each five additional receivers or for each ten additional remote control stations.

The switchboard provides greatly simplified operation when compared with switching systems previously used and reduces the chances of error in circuit selection to a minimum.



EXPLODED VIEW OF SWITCH

FIGURE 2 SWITCHBOARD, RECEIVER TRANSFER SB-973/SRR

In this system the receiver audio will be required in two remote locations, the speaker amplifier, and the radio phone unit.

5. The speaker amplifier AM-215/U is a simple audio amplifier which usually drives one speaker. The volume control should be adjusted to a comfortable listening level.

6. The purpose of the C-1138A/UR Remote Phone Unit is to provide necessary facilities to remotely control certain radio-phone transmitter functions and the output of a radio receiver. Incorporated into the circuitry is the means for turning on or off any standard Navy shipboard transmitter, the means to voice modulate (or key when C-W operation is desired) any standard Navy Shipboard transmitter and the means to monitor and control the output of any standard Navy radio receiver. The unit incorporates POWER and CARRIER ON indicators to provide the remote control operator with this information. Under standard operating conditions, as many as four C-1138A/UR Remote Phone Units or similar units may be parallel connected to a single equipment group (transmitter and receiver) to provide various remote operating positions.

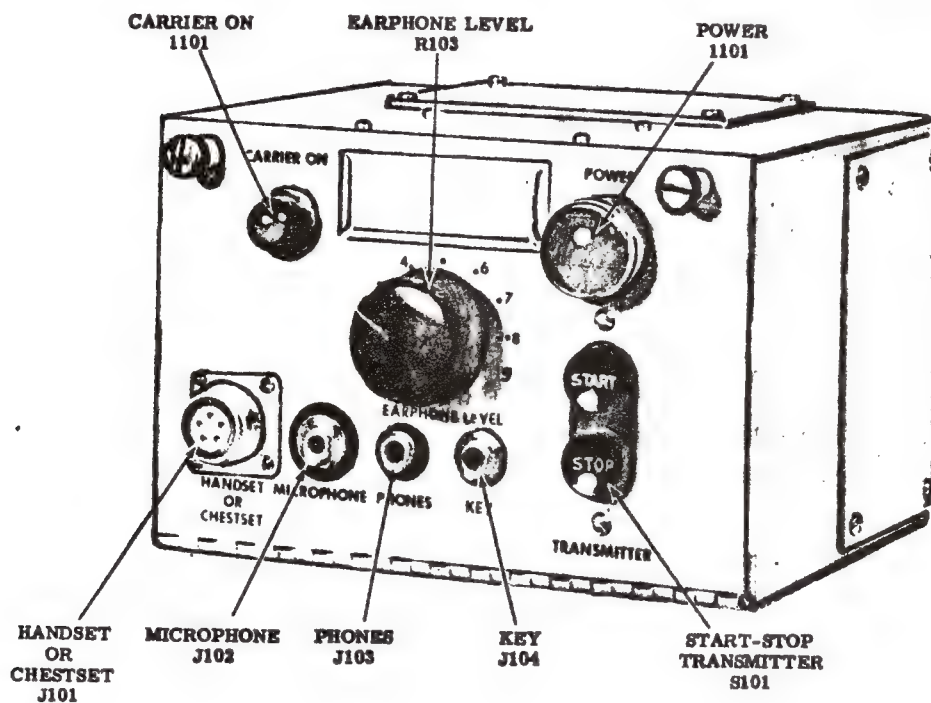


Figure 3. RADIO SET CONTROL, C1138A/ UR, FRONT PANEL

7. The patching of the remote phone unit to the desired transmitter is accomplished at the transmitter switchboard, the operation of which is discussed in the information sheet on CW communications.

8. SSB voice communications in the Navy requires a 3KHz bandwidth. Frequency assignments are so closely spaced that adjacent-channel interference poses a serious threat to RF compatibility. It behooves every technician and operator to ensure that transmissions from their ship do not contribute to this problem. Each time a transmitter is placed on the line, important considerations must be met to preclude the possibility of compromising high quality communications. They are as follows:

- a. FREQUENCY STABILITY: As in the receiver, the frequency stability of a transmitter will be of the upmost importance. It would require only a small amount of frequency drift of the master oscillator to make your transmission unintelligible to the other stations you were calling, as well as interfering with any communications taking place on an adjacent channel.
- b. MODULATION LEVEL: As with an AM transmitter, the SSB transmitter is susceptible to overmodulation and the resultant problems encountered with this form of distortion. The SSB transmitter operating at 100% modulation will have a bandwidth of 3KHz as designed. When the transmitter is modulated past the 100% point, the final amplifier is driven into a nonlinear operation and harmonic radiation occurs outside of the 3KHz bandwidth.

For the purpose of explanation, assume that a SSB transmitter is set on a frequency of 100KHz in the USB mode, and a 2KHz tone is to be transmitted as the intelligence. The resultant output would be as shown in Figure 4 A. In the spectrum there would be one pure frequency at 102KHz.

Figure 4 B is a spectrum analysis of the same transmitter, represented in Figure A, whose output signal has been overmodulated. Notice that the original signal at 102KHz has been greatly reduced in amplitude, and that harmonic radiation occurs every 2KHz above and below the original signal. As undesirable as this is, there is one more form of distortion present; by operating the linear amplifier in a non-linear region, excessive noise is now being generated and radiated to further degrade communications. The power that was lost at the original frequency is now being used to radiate the harmonic signals and noise.

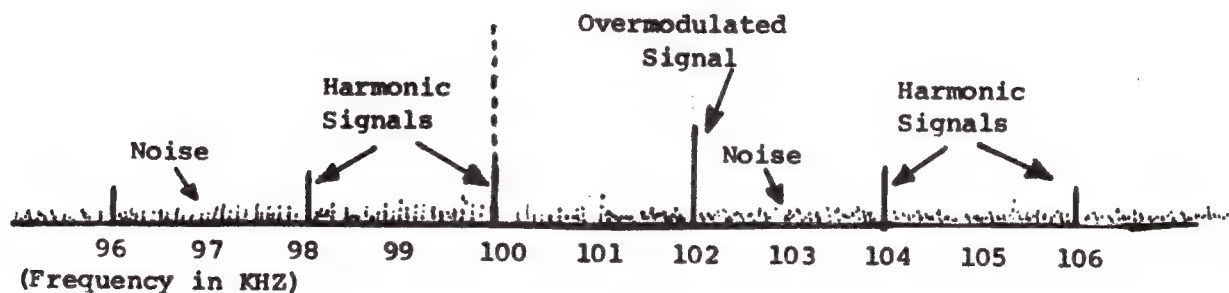
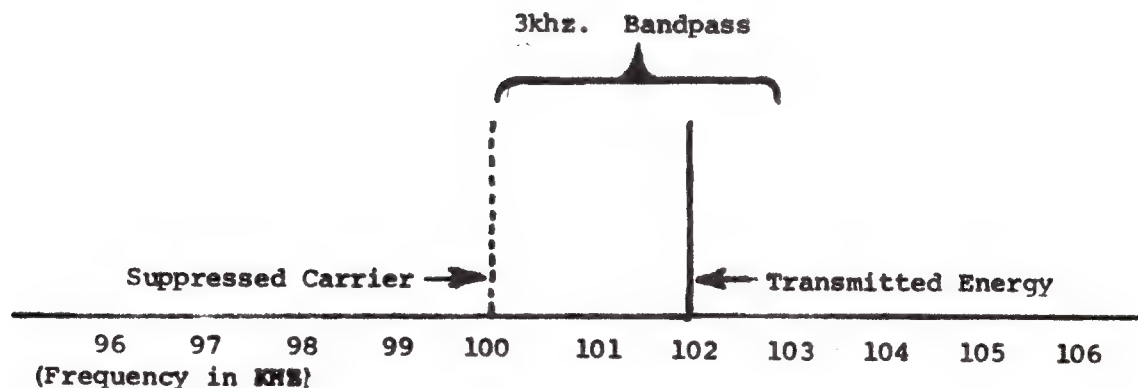


Figure 4.

When a complex waveform such as voice is overmodulated in an SSB transmitter, such distortion occurs, that communications are virtually impossible on either side of the original frequency for several hundred KHz. Therefore, careful setting of the modulation level on any transmitter will always be included in any light-off procedure, regardless of how abbreviated it might be.

UHF DSB AM TELEPHONY COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This information sheet will describe the functional relationship of the equipment used in a typical UHF DSB AM Telephony Communication System.

B. REFERENCES:

1. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK

C. INFORMATION:

1. The UHF DSB AM Telephony Communications System is probably the most used form of radio communications aboard naval vessels. This is due to its short range propagation (line of sight) which makes it "semi-secure", and its high degree of reliability. In the following discussion refer to Figure 1 which is a block diagram of the system.
2. Transceiver operation may be employed in this system, which will serve to reduce the number of antennas required. In multi-transceiver installations aboard ship, the use of multicouplers will further reduce the number of antennas required. In less complex installations, the antenna may be hardwired directly to the transceiver and would not necessitate patching.
3. As with most transceivers, the receiver and transmitter are set-up at the same time. Once the transceiver has been set to the desired frequency, the adjustments to the receiver would include, audio output level, and squelch. On some receivers, (such as the receiver section of the AN/SRC-20, 21) the audio output level of the remote audio line is an internal adjustment, and is usually adjusted when the equipment is installed. This feature precludes the possibility of "operator misadjustment" which could contribute to RF compatibility degradation in the form of audio cross-talk on adjacent audio lines. On other receivers where the audio output level adjustment is a front panel feature, the output level should be carefully adjusted to 0 dbm.
4. The audio output of the receiver is then switched, at a receiver transfer switchboard, to the two remote locations where it will be required-----the speaker amplifier, and the remote phone unit (RPU).

5. If not a function of pre-set channelized tuning controls, the transceiver or transmitter should be properly tuned and adjusted, locally, before being placed in remote operation. It may then be switched to the RPU, at the transmitter transfer switchboard, for remote control and modulation.

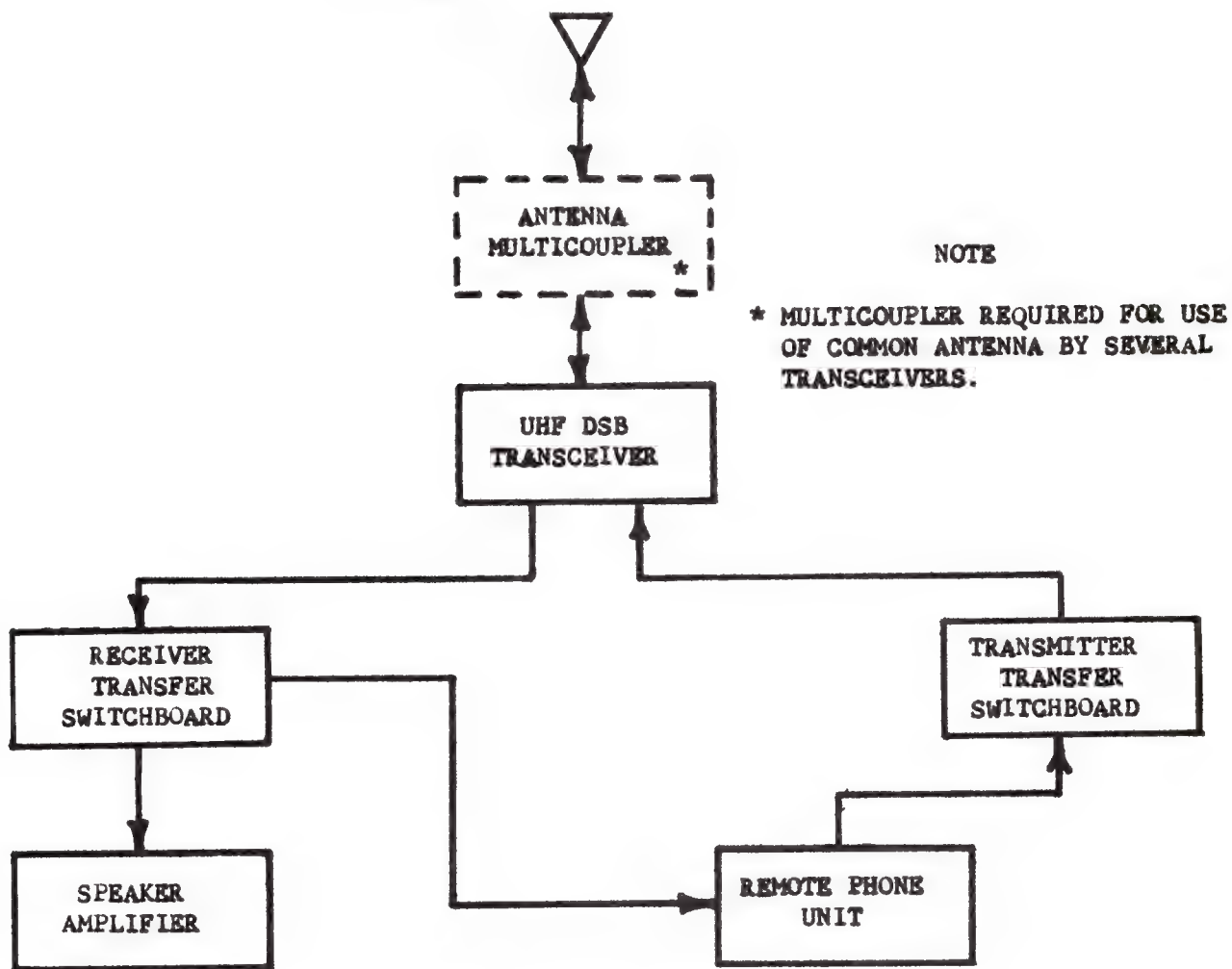


FIGURE 1 UHF DSB AM TELEPHONY COMMUNICATION SYSTEM

UHF-TO-HF VOX RELAY COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This information sheet will describe the functional relationship of the equipments used in a VOX Relay system for the reception and automatic retransmission of voice communications.

B. REFERENCES:

1. NAVSHIPS 0967-307-7010, SINGLE SIDEBAND COMMUNICATIONS
2. NAVSHIPS 94794, C-4621/SR TECHNICAL MANUAL

C. INFORMATION:

1. There are times when a direct communications circuit can't be established between two stations. When such an occasion arises, a third station may be directed to function as an automatic, voice operated (VOX) relay between the sending and receiving stations.

The more common forms of relayed transmissions include telephony and single or multiple channel AFTS RATT. How the VOX relay system is set up depends upon several factors including the modes and frequencies involved, and whether a one-way or a two-way communications relay is required.

2. Figure 1 is a block diagram of a typical VOX relay operation involving two-way communications between a submarine and a shore station. The UHF-to-HF and HF-to-UHF conversions, required for the operation shown, are accomplished in the following manner:
 - a. The submarine transmits to the relay ship on a UHF band.
 - b. The audio signal, from the ship's UHF receiver, is routed to the control unit where it operates a relay which in turn keys an HF transmitter. The same audio also modulates the transmitter.
 - c. The shore station receives the HF transmission and replies with its own HF transmitter.
 - d. The relay ship receives the shore station's transmission on an HF receiver. The audio signal is routed to the control unit where it's used to key and modulate a UHF transmitter. This completes the link to the submarine.

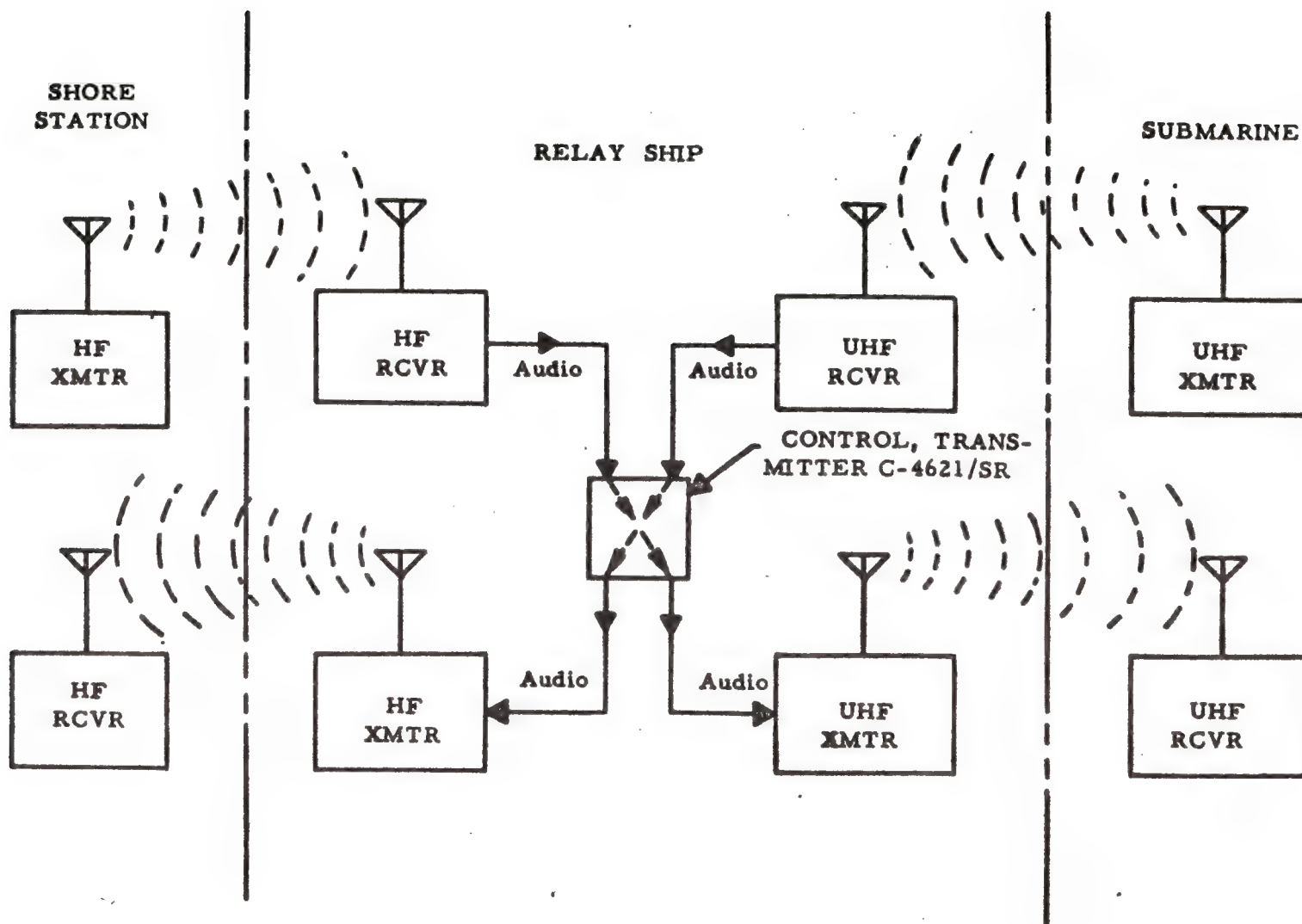


FIGURE 1 TWO-WAY VOX RELAY COMMUNICATIONS CIRCUIT

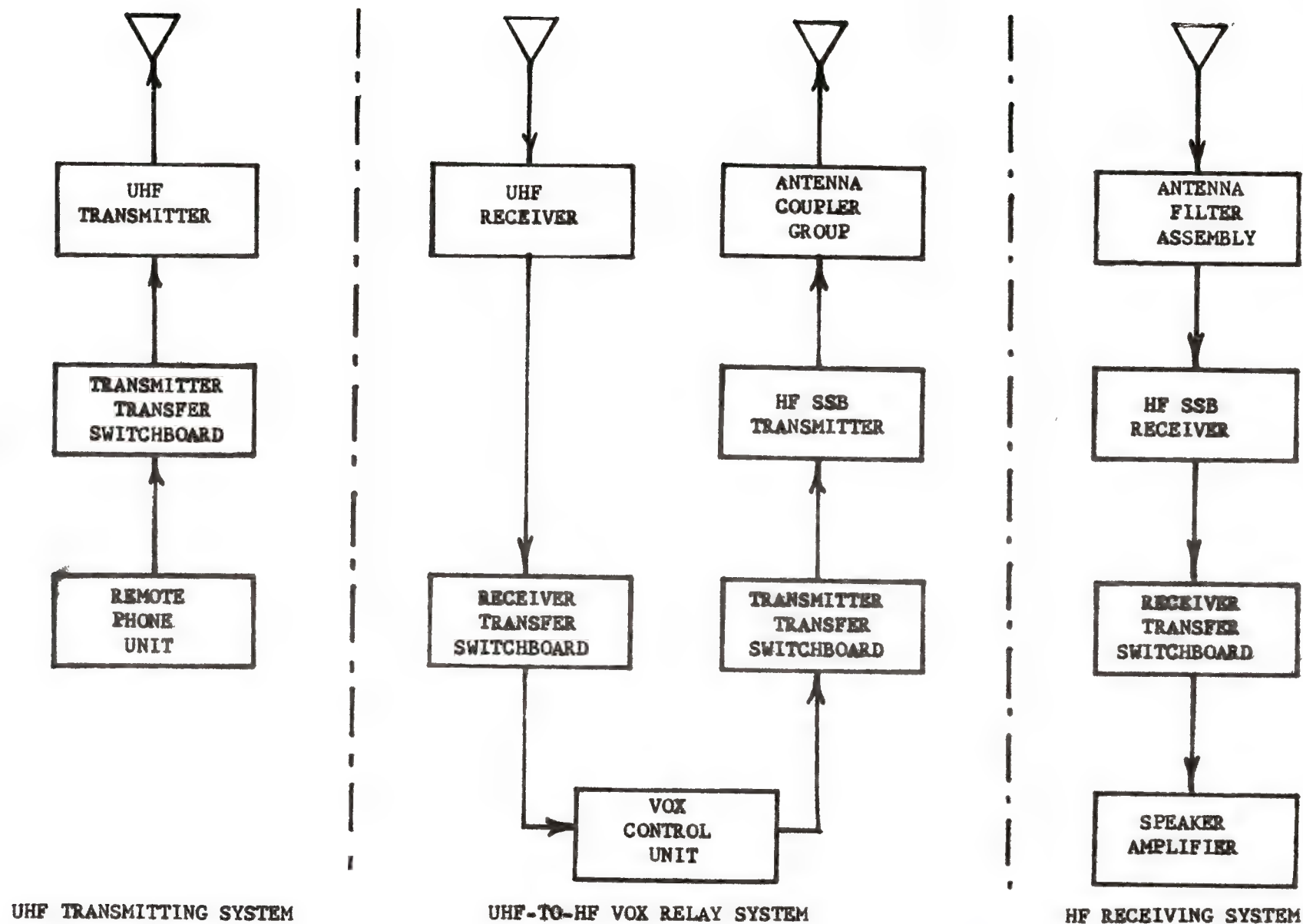


FIGURE 2 ONE-WAY UHF-TO-HF VOX RELAY COMMUNICATIONS CIRCUIT

3. A more detailed block diagram of the systems involved in a one-way UHF-to-HF VOX relay communications circuit is shown in Figure 2. No further discussion of either the UHF transmitting system or the HF receiving system will be entered into by this information sheet. Their operation is essentially the same as previously described by information sheets on HF-SSB and UHF-DSB telephony communication systems.

As indicated by Figure 2, the UHF-to-HF VOX relay system, itself, is not complicated and, with the exception of the VOX control unit, involves the use of relatively familiar equipment. The interconnections required are very similar to those described for other, previously studied, systems.

4. A UHF receiver or transceiver, such as the AN/URR-35 or AN/SRC-21, is used to receive a UHF-DSB AM emission. The audio output is hardwired to a receiver transfer switchboard.
5. At the receiver transfer switchboard, the appropriate switch, for the desired VOX control unit channel input, is rotated to the position number which corresponds with the receiver being used. This completes the audio interconnection between the receiver output and the input terminals for one channel of the VOX control unit.
6. The VOX control unit functions primarily as an automatic relay which allows the received audio to key and modulate a local transmitter. Control, Transmitter C-4621/SR, shown in Figure 3, is one such unit commonly employed for this purpose.

As implied in Figure 1, the C-4621/SR is a dual channel unit which is capable of controlling both transmitters required for a two-way VOX relay operation. This may be accomplished in either a Simplex (when one transmitter is keyed, the other cannot be keyed) or a Duplex (unrestricted keying of either transmitter) mode of operation.

Only one control unit channel is required for the one-way VOX relay system shown in Figure 2, and, since both function in an identical manner, either channel of the C-4621/SR may be utilized. The controls shown in Figure 3 are described in the technical manual and allow the C-4621/SR to be adjusted for proper operation with audio levels ranging from .6 to 2.2 volts rms.

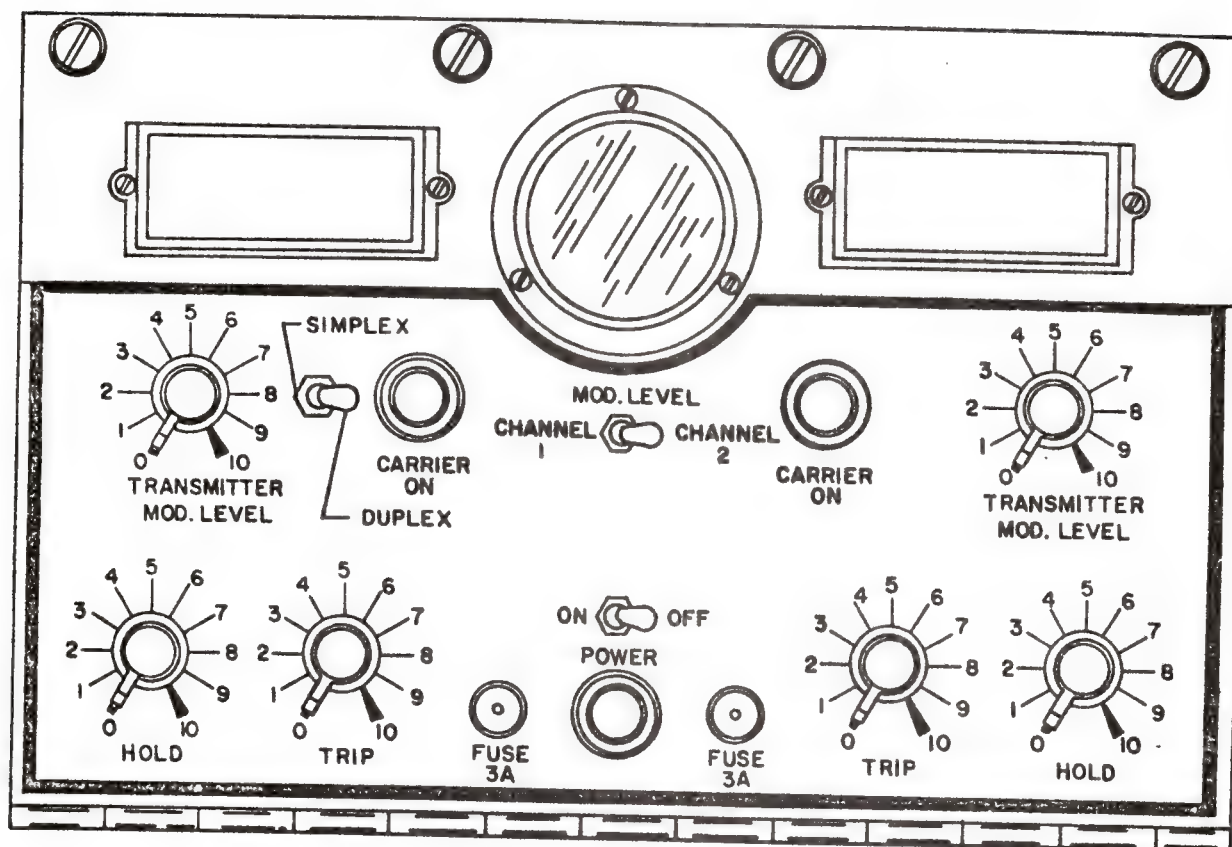


Figure 3 Control, Transmitter C-4621/SR

7. The output of each VOX control unit channel is hardwired to a transmitter transfer switchboard, such as the SB-988/SRT, where it may be switched to remotely control the keying and modulation of a transmitter. This is accomplished by rotating the appropriate switch, for the VOX control unit channel being utilized, to the position number which corresponds with the selected transmitter input. If, as indicated by Figure 2, an HF-SSB transmitter is to be used, different switch positions will correspond to the separate upper and lower side-band inputs.

INFORMATION SHEET 4-1-6I

8. An HF-SSB transmitter, such as the AN/URC-32 or AN/URT-23, should be tuned and adjusted locally, in conjunction with the required antenna coupler, before being placed in remote operation. The transmitter should be placed in independent sideband operation, so that either upper or lower sideband inputs can be selected at the transmitter transfer switchboard.
9. The operation of a properly set-up VOX relay system is completely automatic and doesn't require continual attention. Nevertheless, it's imperative that such things as RF and audio levels be frequently checked and remedial adjustments made to prevent gradual or sudden degradation of communications.

HALF-DUPLEX HF-SSB
AFTS RATT COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This information sheet will describe the functional relationship of the equipments used in a typical Half-Duplex HF-SSB AFTS RATT Communications System.

B. REFERENCES:

1. NAVSHIPS 94972, PP-3495 TECHNICAL MANUAL
2. NAVSHIPS 92279, C-1004/SG TECHNICAL MANUAL
3. NAVSHIPS 94037(B), SB-1203/UG TECHNICAL MANUAL
4. NAVSHIPS 0967-307-7010, SSB COMMUNICATIONS

C. INFORMATION:

1. In any discussion of Radio Teletype, it is very important to understand the relationship that exists between the two methods of RATT that are presently in use in the Navy.
2. The Old FSK RATT system is called Radio Frequency Carrier Shift (RFCS). As illustrated in Figure 2(A), the process involves nothing more than shifting the frequency 425Hz below the carrier or center frequency for the space (0 ma line current), information, and for the mark information (60 ma line current) shifting the frequency 425Hz above the carrier. With this system as with the new, the total shift is 850Hz ($\pm$ 425Hz).
3. The New FSK RATT system is called Audio Frequency Tone Shift (AFTS). As illustrated in Figure 2(B) it is exactly the same as the RFCS signal. The difference is in the way it is generated in the transmitter. With the RFCS transmitter the DC TTY Loop information was converted into small changes in frequency in the master oscillator. With the SSB AFTS Transmitter, the DC TTY Loop information is used to key a two tone audio oscillator whose output is then processed exactly like a voice signal through the transmitter. Due to the signal now being in the USB spectrum, the center of emission is now displaced 2000Hz higher in frequency than the suppressed carrier. The transmitter must now have a carrier frequency (Dial Setting) that is 2000Hz lower in frequency than the assigned frequency of operation. In actual practice this 2KHz dial slippage is taken into account by the person drawing up the ships Comm Plan. The operator who will set-up the transmitter has only to consult this Comm Plan and set the transmitter to the frequency indicated thereon.



Figure 1.

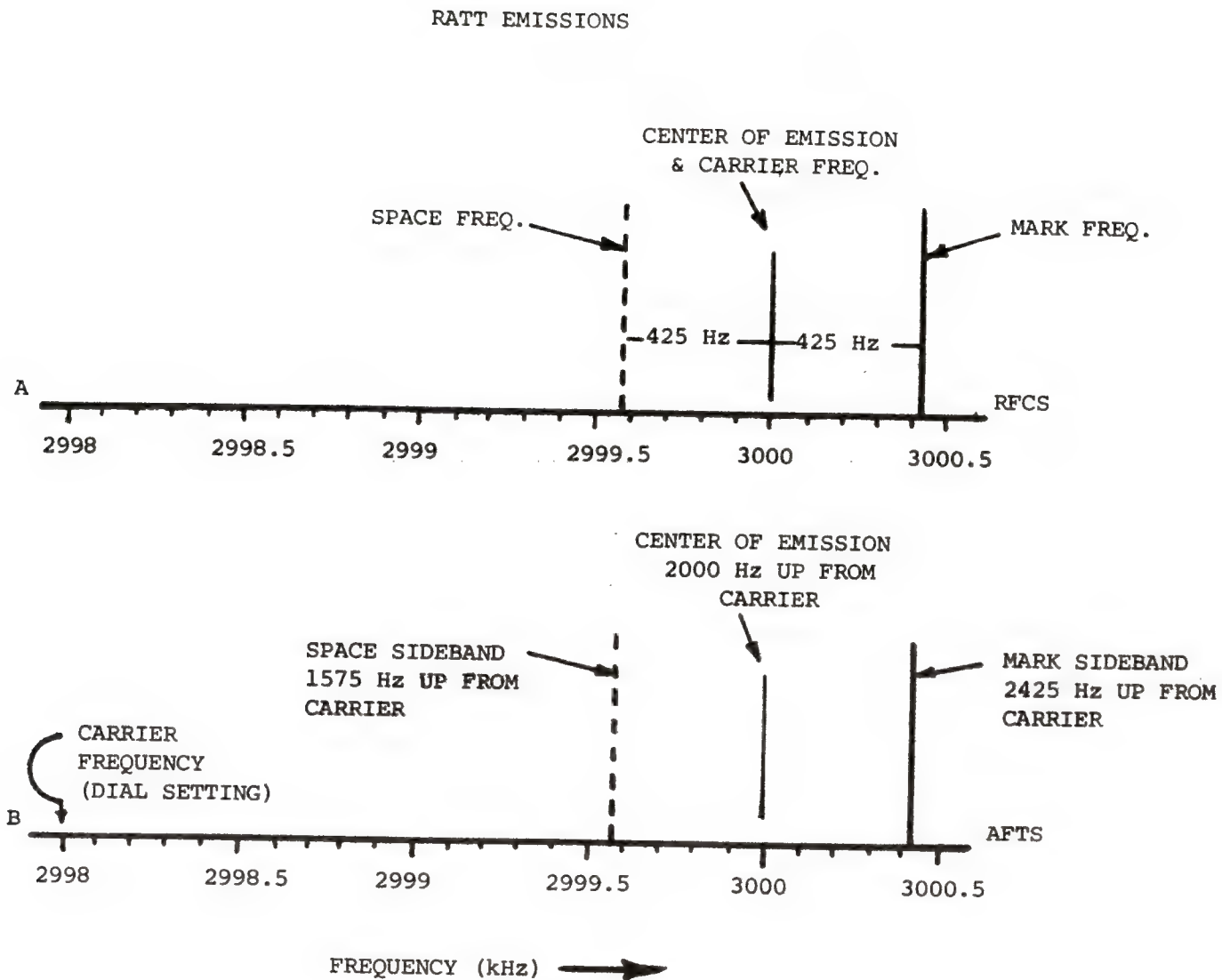


Figure 2. RATT EMISSIONS

INFORMATION SHEET 4-1-7I

4. Antenna selection, patching to the filter assembly, and final patching to the selected receiver will require the same considerations, and procedures discussed in previous information sheets.
5. The RFCS and AFTS emissions (single channel) are identical once they have been transmitted. This will allow more flexibility in the choice of receivers, to intercept the transmission. As an example, the R-390/URR, R-1051/URR, and AN/WRR-2 are all capable of single channel AFTS or RFCS reception.
6. The recovered audio tones are then switched to the appropriate TTY converter through the receiver transfer switchboard.
7. The TTY converter should be carefully adjusted as per instructions in the appropriate technical manual. This will prevent bias distortion which is the major cause of low quality TTY copy.
8. The DC Loop information from the TTY converter is patched to the desired teleprinter through the teletype patch panel. There are two important things to remember when accomplishing this task:
 - a. Patch the DC Loop information to the correct teleprinter. It may sound redundant to mention such an obvious task, but as you will find in system trouble shooting, incorrect patching and switching (be it in the TTY patch panel, receiver switchboard, transmitter switchboard, or antenna patch panel) will be a constant and continuing source of system malfunctions.

NOTE: In most instances, the equipment will be "normalled-through" into the correct loop, and external patching will not be required. When a different loop is required on a specific equipment, it is important to patch in the following order: Insert the patch cord into the "set" first, then insert the opposite end into the loop desired. Deviation from this procedure could result in electrical shock.

- b. Adjust the DC Loop current to 60 Ma only when the system is in a mark condition. It is impossible to guess at the correct setting of this adjustment when the DC Loop has information on it.
9. The DC power supply is hardwired into the TTY patch panel. It has an output of 120 VDC at 1 amp., and will supply sufficient current to operate up to 16 separate loops of information. The on/off switch is the only operational adjustment on this unit.

10. The transmitter/teletypewriter control (illustrated in Figure 3.) is intended to accomplish the following basic function:
 - a. To switch a teletypewriter to either one of the three DC Loops as follows:
 - (1) To a loop in which an automatic half-duplex tone terminal is connected (send/rec. ckt. of the AN/SGC-1).
 - (2) To a loop in which an F-S keyer or transmitter is connected (send ckt.).
 - (3) To a loop in which a F-S converter or comparator is connected (rec. ckt.).
 - b. To provide the following indications:
 - (1) Transmitter "Power On".
 - (2) Transmitter "Carrier On".
 - c. To provide the following remote control functions:
 - (1) Transmitter "On".
 - (2) Transmitter "Off".
11. The operation of the teleprinter is as outlined in your previous studies, and in the operators section of the technical manual.
12. The transmitter will be remotely controlled by the C-1004/SG which is patched through the transmitter switchboard. The DC Loop information to the transmitter must be patched at the TTY patch panel.
13. The SSB transmitter is subject to the same misadjustments as in systems previously described. Provisions are usually included, (either automatically or by external adjustments) to insure that the AFTS signal is set to the correct level so that overmodulation will not occur.

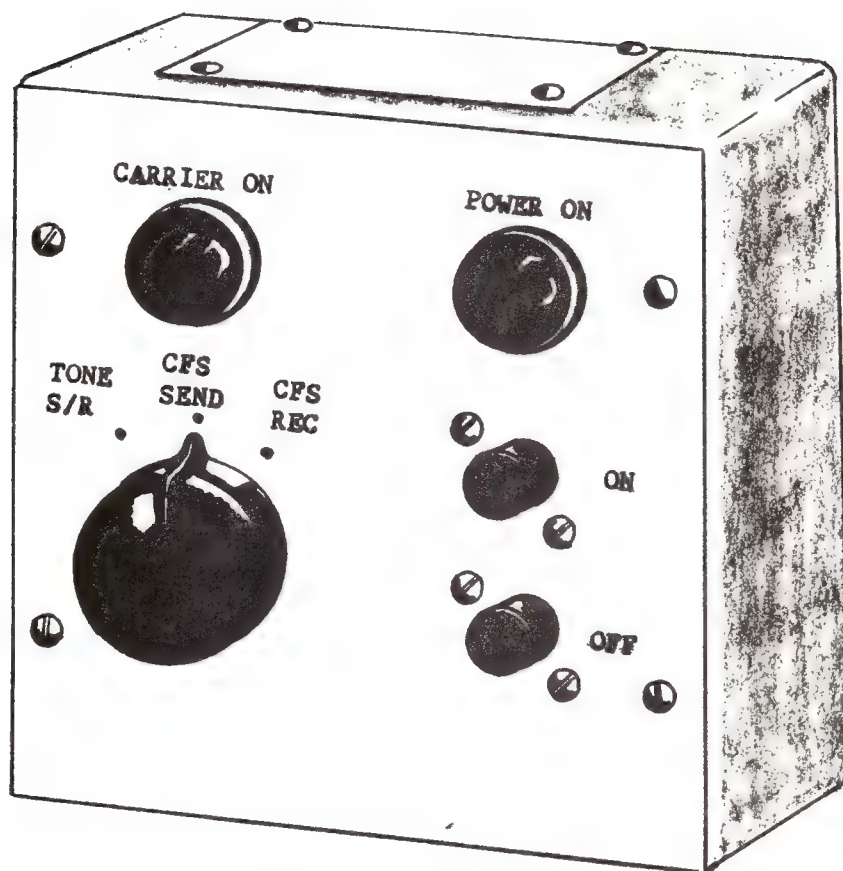


FIGURE 3 C-1004A/SG TRANSMITTER TELETYPEWRITER CONTROL

HF-SSB AFTS MULTI-CHANNEL RATT
COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This Information Sheet will describe the functional relationship of the equipments used in a typical HF-SSB AFTS Multi-Channel RATT Communications System.

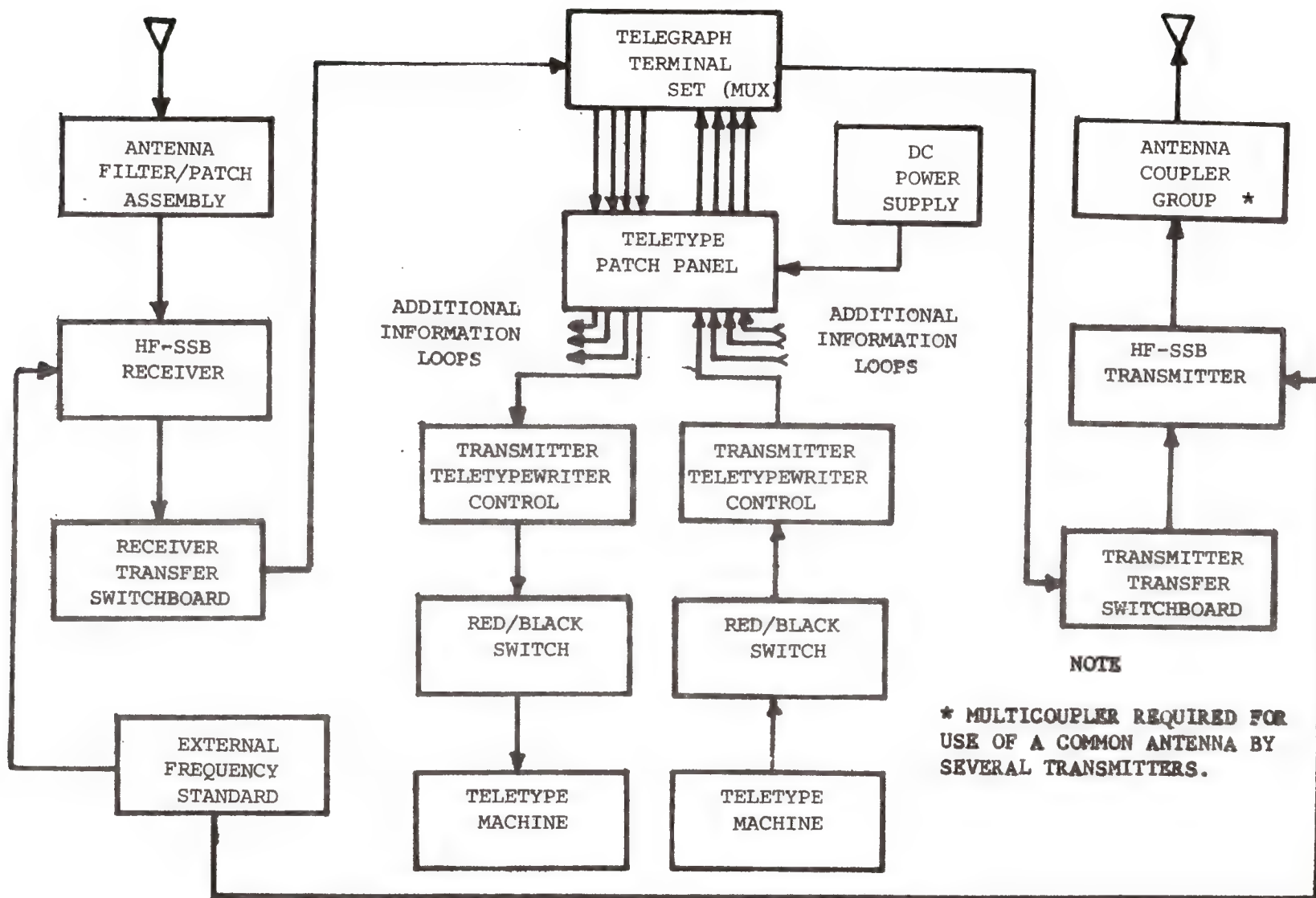
B. REFERENCES:

1. NAVSHIPS 0967-239-4010, AN/UCC-1D(V) TECHNICAL MANUAL.
2. NAVSHIPS 0967-307-7010, SSB COMMUNICATIONS.
3. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK.

C. INFORMATION:

1. Multi-Channel RATT operating procedures, tests, and recommendations are thoroughly covered in Reference 3, Chapter 5.4, Paragraph A through F, and Reference 2, Chapter 2.6, Page 52-61. You are encouraged to read both references before proceeding further in this Information Sheet.
2. The receive side of this system is identical to the HF-SSB voice system previously described (Refer to Figure 1.).
3. The recovered tone package is switched to the desired input channel of the Multiplex Terminal Set at the receiver transfer switchboard.
4. In this system, the AN/UCC-1D(V) converters are used in a "twin" diversity configuration and only one information channel will be received. It is well to remember that this particular system, as designed, (Refer to Figure 1.), is capable of handling four different information channels simultaneously.
5. The DC output of the converters is hardwired into the TTY patch panel from which the output may be "normalled through" to a given teleprinter or patched to any other selected teleprinter.
6. The DC is then routed through the transmitter teletypewriter control unit (C-1004/SG) which must be in the "FS REC" mode.
7. The DC Loop is hardwired from the C-1004/SG to the Red/Black switch. In this system, the transmission is non-secure, and the switch must be set to the "Black" position.

39



HF-SSB MULTICHANNEL RATT
COMMUNICATIONS SYSTEM

Figure 1.

INFORMATION SHEET 4-1-8I

8. The DC Loop from the Red/Black switch is fed directly to the teletypewriter for the information read-out, completing the receive side of the system.
9. The transmit side of the system starts at the teletypewriter where the information is typed on the keyboard or fed into the system on a tape through the transmitter distributor (TD). From this point, the DC Loop is hardwired into the Red/Black switch.
10. This transmission is non-covered, so the Red/Black switch must be placed in the "Black" position. From this unit, the DC Loop is hardwired to the transmitter teletypewriter control unit, C-1004/SG.
11. The C-1004/SG must be placed in the "FS SEND" mode of operation. This inserts the teletypewriter into a send DC Loop that is routed through the TTY patch panel to the selected tone keyer, or tone keyer "Twinning" combination, in the AN/UCC-1D(V).
12. The output tone package of the MUX terminal is routed to the transmitter transfer switchboard where it is switched to the appropriate remote line (audio) input of the selected transmitter.
13. In this system, the transmitter normally receives only the composite tone package from the transmitter transfer switchboard. Accordingly, while the transmitter must be set up to operate with a remote audio input, the required constant key is usually effected locally.
14. The transmitter in this system requires particular attention in the following areas:
 - a. Input Level. Special precautions must be observed at the MUX terminal to insure that the tone package output is always adjusted (at the control attenuator of the AN/UCC-1D(V) to a level of 0 dbm. This adjustment will always be required when new tones are added or dropped from the tone package.
 - b. Transmitter Power Out. Figure 33, on Page 60 of Reference 2, illustrates the correct watt meter reading on a 1000 watt P.E.P SSB transmitter for the total number of tone pairs present. Transmitter power-out must always be adjusted to ensure that these average values are never exceeded.
 - c. Frequency Stability. In all MUX systems, the accuracy and stability of the transmitted signal is of extreme importance. In some systems, a frequency error in excess of 5Hz will render the copy garbled and unreadable. The most effective means of insuring that a transmitter remains "on frequency" is the continuous use of an external frequency standard, (AN/URQ-9 or AN/URQ-10).

Strict adherence to the above listed considerations will greatly enhance system RF compatibility.

UHF AFTS RATT COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This information sheet will describe the functional relationship of the equipments used in a typical communication system for the reception and transmission of UHF DSB AFTS RATT in a half-duplex operation.

B. REFERENCE:

1. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK.

C. INFORMATION:

1. UHF AFTS RATT is probably the only common form of radio telecommunications that must employ DSB AM as the operational mode. Despite such a limitation, UHF AFTS RATT may be used to accomplish either single or multi-channel communications in either half or full-duplex circuit operations. Figure 1 is the block diagram for a system which is capable of sending and receiving only single-channel intelligence in a half-duplex operation. Such an operation allows the use of a transceiver only if the same frequency is used for both transmission and reception. If different frequencies are involved, a separate transmitter and receiver would be required even though transmission and reception is non-simultaneous in a half-duplex operation.
2. During reception, the audio output from the receiver section of a UHF transceiver, such as the AN/SRC-21, is routed to the input of a tone terminal set via a receiver transfer switchboard.

If not a function of pre-set internal adjustments, the receiver controls should be adjusted to provide an output level of 0 dbm during reception. In addition, care must be taken to insure that receiver noise is properly squelched when no signals are present.

3. The AN/SGC-1 is adequate for use as the tone terminal set shown in Figure 1 since only single-channel intelligence processing is required. This equipment may be set up and used strictly for reception as a tone-to-DC converter; strictly for transmission as a DC-to-tone converter; or for both in an automatic transceiver operation.

Automatic operation is required of the AN/SGC-1 for use in the system presently being described. The procedures contained in the technical manual should be followed to insure the equipment is set up to function properly.

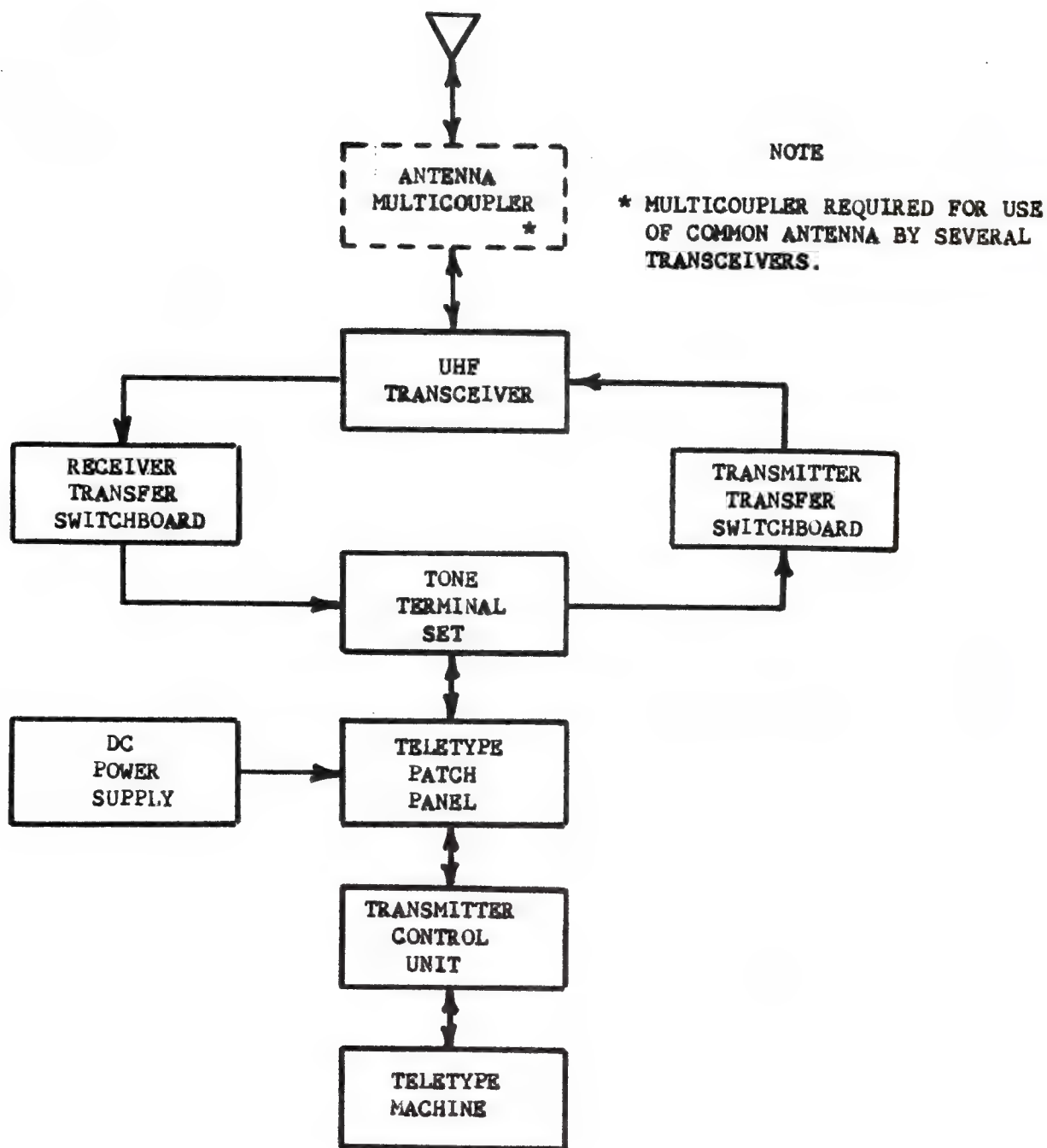


FIGURE 1 UHF APTS RATT COMMUNICATIONS SYSTEM

In the automatic mode of operation, the AN/SGC-1 remains in a standby mode until triggered into either a transmit or receive condition. A shift into the receive condition is caused by an incoming audio signal and the equipment then functions to convert the two-tone intelligence into corresponding Mark/Space pulses on an external DC Loop.

It is important to note that excessive receiver noise, if not squelched, can, in itself, also cause the AN/SGC-1 to shift from standby into a receive condition. This situation may be avoided by proper adjustment of appropriate receiver or transceiver controls.

4. When a single-channel tone terminal set, such as the AN/SGC-1, is used for both transmission and reception in a half-duplex operation, only one DC Loop is required. The tone terminal set is inserted into the DC Loop through hardwired interconnections with a teletype patch panel, such as the SB-1203/UG. The necessary power for the DC Loop is provided through hardwired interconnections between the patch panel and a power supply.

A Local Teletypewriter Position (LTP) is normalled through to the tone terminal DC Loop by hardwired interconnections between the appropriate set jack, at the patch panel, and the TONE S/R switch position of the designated LTP transmitter control unit. No patching is required at the patch panel if the normalled through LTP is to be utilized.

5. The transmitter control unit, such as a C-1004A/SG, is located at, and hardwired to, a teletypewriter machine at the LTP. The function selector switch on the C-1004A/SG is left in the same position (TONE S/R) for both sending and receiving operations. Remote transmitter keying is not a function of the control unit, for the system shown in Figure 1, and it simply acts to place the teletypewriter in the same DC Loop as the AN/SGC-1.
6. During reception of DC Mark/Space pulses from the AN/SGC-1, the teletypewriter functions to automatically decode and print out the corresponding intelligence. Upon termination of the incoming message, the AN/SGC-1 returns to a standby function and the teletypewriter reverts to a steady idle or "locked up" condition.

For transmission, the local operation of the teletypewriter causes DC Mark/Space pulses to be placed on the DC Loop. The initial DC pulses cause the AN/SGC-1 to shift from standby to a transmit condition. In this condition, the AN/SGC-1 keys the transmitter and functions to provide modulation by converting the DC Mark/Space pulses into corresponding two-tone audio intelligence.

INFORMATION SHEET 4-1-9I

The tone terminal set should be adjusted to provide an audio output level of 0 dbm for proper transmitter modulation. Hardwired interconnections route both the keying control and audio output from the tone terminal set to the transmitter section of the desired transceiver via the transmitter transfer switchboard.

MULTI-CHANNEL HF-SSB-AFTS
(Simulated Secure) RATT
Communications System

A. INTRODUCTION:

This information sheet will briefly describe the functional relationship of the equipments used in a (simulated) secure portion of a Multi-Channel RATT Communications System.

B. REFERENCES:

1. NAVSHIPS 0967-307-7010, SSB COMMUNICATIONS

C. INFORMATION:

1. Descriptions of individual crypto equipments are classified and are not included in this information sheet. Suffice it to say, that the automatic or "On-Line" systems all depend on a random scrambling of the TTY code pulses, initiated at certain time intervals. Timing and synchronization is the essence of the operation of these systems. Cryptographic devices are DC pulse-operated, and must be inserted between the teletype machines and the MUX keyers; or, between teletype machines and receiving MUX converters.
2. The simulated secure system block diagram is illustrated in Figure 1. NOTE: The receive and transmit sub-systems are identical to those used in the HF SSB Multi-Channel RATT System and are, therefore, neither shown nor described by this information sheet to avoid needless repetition.
3. Receive Side
 - a. The receive DC information loop from the MUX converter is hardwired into the TTY patch panel (Black). From this point, the DC loop is patched into the (simulated) secure decoding device.
 - b. The (simulated) secure decoding device output is hardwired into the TTY patch panel (Red). From here, the DC Loop is (1) "normal-through" to a Red/Black switch, or (2) patched to any other selected Red/Black switch.

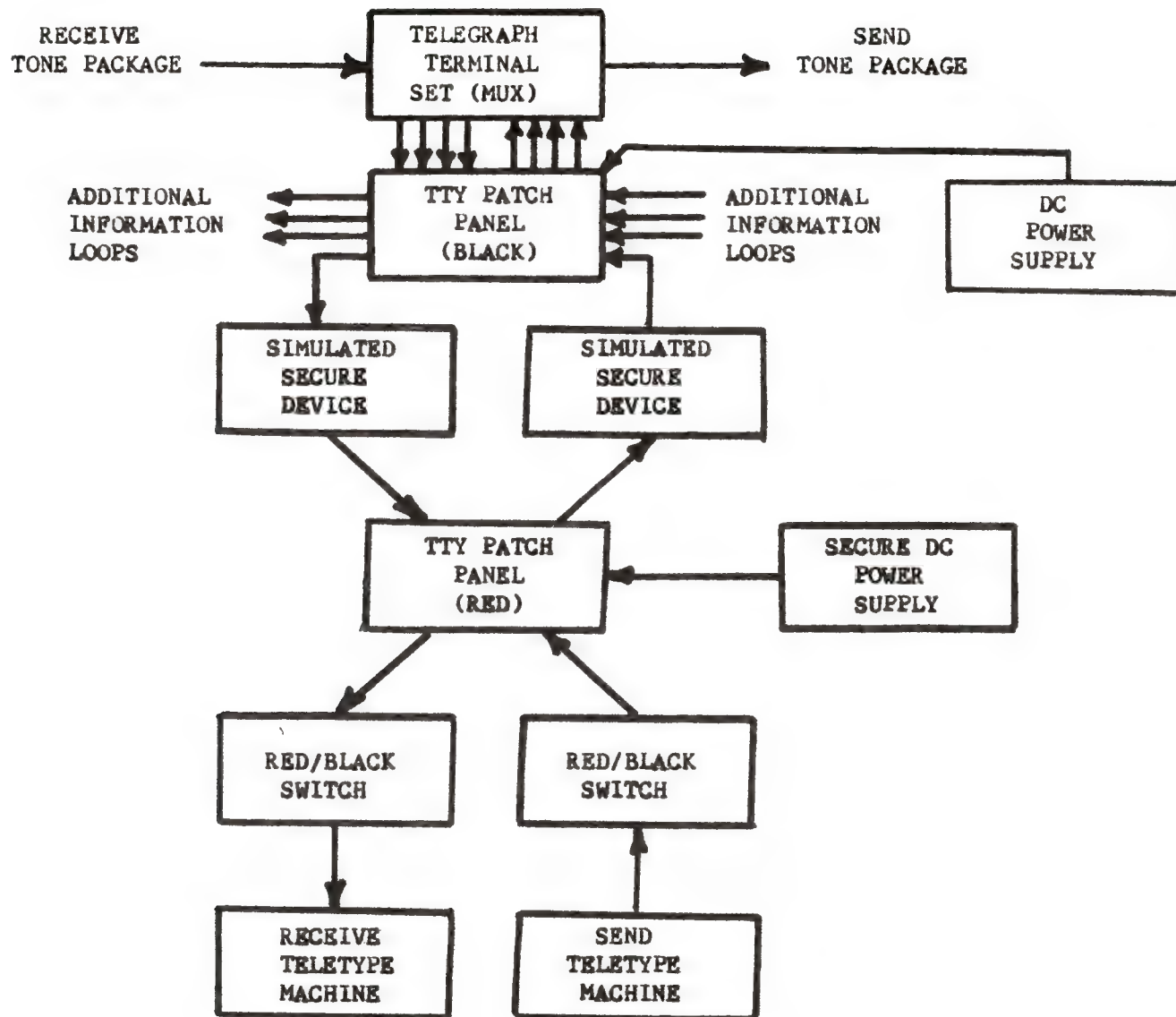


FIGURE 1 SIMULATED SECURE MULTI-CHANNEL HF SSB RATT COMMUNICATIONS SYSTEM

- c. From the Red/Black switch, the DC Loop is hardwired into the TTY machine.

4. Send Side

- a. The send DC Loop starts at the TTY machine and is hardwired into the Red/Black switch.
- b. From the Red/Black switch, the DC Loop is hardwired to the TTY patch panel (Red) where it is either "normal-through" to a (simulated) secure encoding device, or patched to another selected (simulated) secure encoding device.
- c. The output of the (simulated) secure encoding device is hardwired into the TTY patch panel (Black) where it may be patched into any selected MUX tone keyer.

SYSTEM BLUEPRINTS

A. INTRODUCTION:

1. This information sheet describes several types of electronic system blueprints in terms of their purpose, selection, and interpretation.

B. REFERENCES:

1. NAVPERS 10077-C, BLUEPRINT READING AND SKETCHING.
2. NAVSHIPS 0967-000-0110, EIMB, INSTALLATION STANDARDS.
3. NAVSHIPS 0967-000-0140, EIMB, REFERENCE DATA.

C. INFORMATION:

1. Up to now, you have been primarily concerned with individual communications equipment. In your study of this equipment, it has been imperative for you to become completely familiar with the block diagram of each equipment, not only to aid in your study of the operation of the equipment, but to aid in isolating a problem to a specific functional block within the equipment. In a system, it is imperative that you become completely familiar with the blueprint of that system in order to isolate a problem to a specific equipment within the system. A blueprint is not unlike the block diagram of a specific equipment, when a problem occurs, you must be able to select the required blueprint and be able to interpret the information it contains in order to isolate the problem.
2. All blueprints, which pertain to electronics systems, should be indexed by title and number for availability to all electronic technicians. For any given system, the electronics technician will have several types of blueprints available. A knowledge of the information contained in the different types of blueprints is helpful in selecting the necessary blueprint, seven common types of blueprints are:
 - a. Pictorial Wiring Diagram - a diagram showing actual pictorial sketches of the various parts of an equipment and the electrical connections between the parts.
 - b. Isometric Wiring Diagram - a diagram showing the outline of a ship or aircraft or other structure, and the location of equipment such as panels, connection boxes and cable runs.
 - c. Wiring (Connection) Diagram - a diagram showing the individual connections within a unit and the physical arrangement of the components.

- d. Schematic Diagram - a diagram using graphic symbols to show how a circuit functions electrically.
 - e. Elementary Wiring Diagram - (1) a shipboard wiring diagram showing how each individual conductor is connected within the various connection boxes of an electrical circuit or system. (2) a schematic diagram; the term elementary wiring diagram is sometimes used interchangeably with schematic diagram, especially a simplified schematic diagram.
 - f. Block Diagram - a diagram in which the major components of an equipment or system are represented by squares, rectangles, or other geometric figures, and the normal order of progression of a signal or current flow is represented by lines.
 - g. Single Line Diagram - a diagram using single lines and graphic symbols to simplify a complex circuit or system.
3. Military blueprints are required to contain certain information according to the format set forth by Military Standard (MIL-STD)-100A. A title block is required and will be located in the lower right hand corner of the blueprint. The title block (Figure 1.) contains the name of the part or assembly that the blueprint represents, the drawing number, the scale of the drawing, and the number of pages comprising the blueprint. The name of the organization preparing the blueprint is located at the top of the title block.

If there are any revisions to the blueprint, a revision block will be located in the upper right hand corner. All revisions are noted in this block, and are dated and identified by a letter and a brief description of the revision. A revised blueprint is indicated in the title block by placing a letter after the drawing number in the space provided as shown in Figure 1. If the blueprint is revised again, the letter A in Figure 1 would be replaced by the letter B.

DES. <i>R. HATHAWAY</i>		DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND			
DRWN. <i>R. HATHAWAY</i>		U.S. NAVAL STATION, WASHINGTON, D.C.			
CHK. <i>B.W. Duck</i>		<i>INSTALLATION OF NEW LIGHTING</i> <i>BLDG. 220-3E4</i> <i>WASHINGTON NAVY YARD</i>			
SUPV. <i>T.A. Barrett</i>					
IN CHARGE <i>E. GRANT</i>					
SATISFACTORY TO <i>W.C. Johnson</i>					
APPROVED <i>J.R. Jones</i>	DATE <i>5/17/68</i>	CODE IDENT NO. <i>80091</i>	SIZE <i>F</i>	DRAWING NO. <i>1167420</i>	REV <i>A</i>
APPROVED <i>John E. Hayes</i>	DATE <i>5/12/68</i>	SCALE $\frac{1}{8} = 1'$		SPEC. 82805/68 NBY 82805	SHEET 1 OF 1
OFFICER IN CHARGE		PUBLIC WORKS OFFICER			

Figure 1.

Located directly below the revisions block is the legend which explains or defines any symbols or special marks placed on the blueprint. A table of graphic symbols for electrical and electronics diagrams can be found in Reference 3 (Pages 3-168 to 3-177). The bill of materials is located below the legend and contains a list of parts and material required by the blueprint.

4. On blueprints which show each conductor and its connection between equipments in a system, a cable identification number is assigned to each conductor. Each cable identification number for electronics equipment interconnection service begins with the letter "R" immediately followed by a "segregation" marking, letters designating the system, and the number of the cable within the system.
5. The cable segregation letter, which follows the letter "R" in a cable identification number, classifies the cable as active, susceptible or passive depending on the use of the cable as indicated below.
 - a. ACTIVE CABLES (High Level). - Indicated by the letter "A" and includes:
 - (1) Radar modulator pulse cables.
 - (2) Radio transmitter antenna transmission lines (except UHF and VHF).
 - (3) Sonar transducer cables (when transmitting).
 - b. SUSCEPTIBLE CABLES (Low Level). - Indicated by the letter "S" and include:
 - (1) Radio receiving antenna cables including LORAN, ECM and AEW.
 - (2) Sonar transducer cables (when receiving).
 - (3) Sonar hydrophone cables.
 - (4) Transceiver cables (including IFF).
 - c. PASSIVE CABLES (Medium Level). - Indicated by no letter and include:
 - (1) Power and lighting cables.
 - (2) IC and FC cables.
 - (3) Control cables.
 - (4) Electronic cables other than those designated as either active or susceptible.
6. The system designation letters following the cable segregation marking indicates the system in which the cable is used and the system number indicates the specific cable within the system. The system cables are numbered consecutively from "1" beginning at the unit where the ship service power connects, or at the focal point of the

system. Refer to Reference 2 (Pages 4-16-3 and 4-16-4, Table 16-1) for a complete list of electronic systems designation letters. Designation letters common to communications systems are:

RA - Radio antenna
RR - Radio receiving circuits
RT - Radio transmitter control
RY - Radio teletype

7. When two or more identical systems are installed, the system will be identified by placing numbers in sequence beginning with "1" before the electronic identification letter "R". For example:

2RS-RR3 The number two indicates that this cable is a part of the second, of two or more systems having identical designating letters. "R" indicates an electronic system and the "S" indicates a low level susceptible cable. "RR" indicates a radio receiver system and the number "3" indicates that this is the third cable of the system.

R-RT7 The first letter "R" indicates an electronic system. "RT" indicates a radio transmitter system and the number "7" indicates that this is the seventh cable of the system. The absence of a number before the first letter "R" indicates that there is only one system of this type. The absence of a letter after the first letter "R" indicates that this is a passive cable (medium level).

8. Cables supplying power to electronic equipment systems will carry the designation specified for power and lighting systems. This applies only to the supply cable up to the first electronic unit of the system or to the power receptacle to which the unit connects. Interconnection power cables between electronic system units will carry the electronic identification letter "R".
9. In an electronic system, all permanently installed cables are tagged with the identification number as it appears on the blueprint. These tags will be as close as possible to each point of connection. Tags are also placed on the cable on both sides of bulkheads, decks, and other barriers, and at intervals so that cable length between tags does not exceed 50 feet. Where cable runs are short and straight (such as vertical runs between decks) and where a second set of tags serves no useful purpose, a single set within a compartment will be adequate. Cables that are located wholly within a compartment and can be easily traced are not normally tagged. Tags should be attached to a straight portion of cable and positioned so that they can be easily read.

10. In some cases, a running wire list instead of a wiring diagram will accompany the system blueprint. A running wire list is a written form of a wiring diagram which lists all of the cables within a system and their points of connection.
11. On most blueprints a second number, in addition to the cable identification number, will be found next to each cable. The number indicates the type and size of the cable used.
 - a. The general construction of the cable is indicated by the type letters. These are the first letters of the words used in describing the general construction of the cable.

EXAMPLE. - TYPE MHFA. - The general construction of this cable is multiple conductor, heat and flame resistant, armored.

- b. The size designation is related to the conductors contained within the cable and may indicate one or more of the following:

- (1) CONDUCTOR SIZE. - The conductor size is indicated by the approximate cross sectional area of the conductor expressed in thousands of circular mils.

EXAMPLE. - SSGA-9. - The circular mil area of the conductor in this cable would be approximately 9,000 circular mils.

- (2) CONDUCTOR SIZE AND NUMBER OF STRANDS. - The approximate cross sectional area of the conductor in thousands of circular mils is indicated by the first number group and the number of strands in the conductor is indicated by the numbers in parentheses.

EXAMPLE. - SRI-1 1/2 (41). - The circular mil area of the conductor in this cable is approximately 1,500 circular mils and the conductor is made up of 41 individual strands.

- (3) NUMBER OF CONDUCTORS. The number of conductors contained within a multiple conductor cable will be indicated by the size number.

EXAMPLE. - MSCA-10. - This cable would contain 10 conductors of an identical circular mil area.

- (4) TWISTED PAIRS. - The number of twisted pairs contained within a multiple conductor type cable will be indicated by the size number.

EXAMPLE. - TTHFWA-20. - This cable would contain 20 twisted pairs of conductors with identical circular mil areas (a total of 40 individual conductors).

INFORMATION SHEET 4-2-1I

A complete description of each cable type can be found in Reference 2 (Pages 4-1-1 to 4-2-114). A complete list and description of coaxial cables can also be found in Reference 2 (Pages 5-1-1 to 5-2-65).

SYSTEMS MAINTENANCE

A. INTRODUCTION:

1. This information sheet briefly describes procedures that may be effectively utilized to help prevent and/or isolate communication system malfunctions.

B. REFERENCES:

1. OPNAV 43Pl, PLANNED MAINTENANCE SYSTEM MANUAL.
2. NAVPERS 94381, LOGICAL TROUBLESHOOTING PROCEDURES.

C. INFORMATION:

1. In order for a given system to function correctly, each equipment involved must operate properly. Since applied preventive maintenance has proven to be an effective method of enhancing equipment operation and reliability, it follows that such action will also have the same influence on the performance of user systems.

The Planned Maintenance System (PMS) provides the procedural tools, for effective preventive maintenance, in the form of Maintenance Requirement Cards (MRC). Most MRC forms outline procedures for conducting a specific check, or maintenance, on a particular equipment. Such PMS checks are normally scheduled for accomplishment on a cycle requirement basis.

2. Systems Readiness Tests (SRT's) have been developed, as a logical extension of PMS, and outline procedures for rapidly determining the operational readiness status of electronic systems and associated equipments. SRT's are also prepared on MRC forms and are used by maintenance personnel to establish equipment operability with regard to a functional system concept.

In order to permit the widest possible application, the information contained on a given SRT MRC is necessarily generalized and pertains to all systems of the same functional type. Because of this, some SRT MRC's provide blank spaces which should be filled in, with data pertinent to the particular installation, before it's used.

SRT's are not scheduled for accomplishment on a cycle requirement basis. Instead, they are tentatively scheduled and conducted according to situation requirements. It's quite common for SRT's to be conducted just prior to a ship getting underway. Such action allows malfunctions to be disclosed, and corrective action taken, before the systems are required for actual operations.

The more commonly used SRT MRC's include those provided for the following:

- a. LF/MF/HF Communication Receiving Systems
 - b. LF/MF/HF Communication Transmitting Systems
 - c. VHF/UHF Communication Systems
 - d. Radio Teletype Systems
 - e. Communication Remote Systems
3. Unfortunately, even the most effective preventive maintenance program will not totally eliminate the occurrence of malfunctions during system operation. When such a malfunction occurs, an experienced operator will frequently have the problem area localized even before the technician arrives to initiate corrective action. Such assistance is not always available, however, and the technician must himself be able to systematically isolate the cause of the malfunction.

The six-step troubleshooting procedure is just as valid, and effectively used, for isolating the cause of a system malfunction as it is for locating the defect in a prime equipment. This is because, when viewed functionally, given systems and prime equipments are very similar. Whereas a given equipment, such as a communications transmitter, is comprised of functional units, sub-units and/or sections that are usually centrally located and interconnected, a given system is made up of functional sub-systems, equipments and units that are physically separated and interconnected.

Such similarity between a system and an equipment is not made readily apparent by a comparison of blueprint and technical manual functional block diagrams. This is because, whereas technical manual illustrations usually pertain to a specific equipment, blueprint diagrams are more comprehensive and show the overall arrangement of units that may be independently, or simultaneously, involved in one, or more, individual system operations. The technician must, therefore, be familiar with how a given system operates, in terms of its functional unit requirements and relationships, before he can segregate and trace the system on a blueprint.

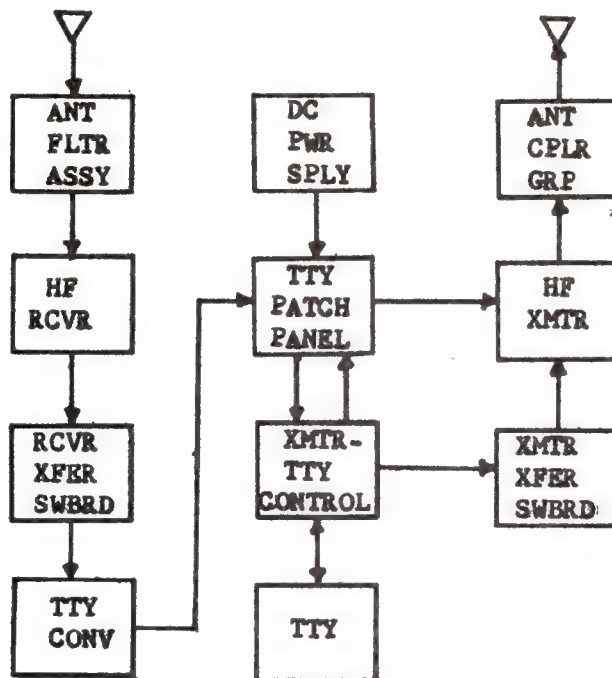
4. The first troubleshooting step, for locating the problem in a malfunctioning system, is the recognition of a trouble symptom. This may or may not be an easy task depending on the nature of the problem. Disrupted or seriously degraded system performance is obvious and will usually be reported by the operator.

Occasionally the first trouble symptom will be of a non-repetitive nature and, while noted by the operator, cannot be duplicated and observed later by the technician. It, therefore, behooves the technician to find out if the operator noted any symptoms that are no longer present, when initially responding to a reported problem.

Other, less disruptive, problems may not exhibit readily apparent trouble symptoms during normal operation of a system. The disclosure of such a problem is usually the result of close observations made during the application of Systems Readiness Tests or at the time the system is initially set up.

Unless the problem has already been localized when the technician arrives, his first step is to establish the nature of the malfunction as concerns the overall operation of the given system. This is normally accomplished at the operator position by correlating the complaint reported with the trouble symptom that may be observed firsthand, such as disrupted or degraded transmission or reception.

5. In Step 2, the technician should attempt to further localize the problem area by looking for other indications, both abnormal and normal, that tend to elaborate on the trouble symptom noted in Step 1. The determination of which indications would be the most beneficial, and how and where they can be observed, depends upon the nature of the problem, the type of system involved, and the installed arrangement of the equipment actually being utilized.



For an example of how the technician might proceed through Step 1 and Step 2, assume that a given HF RATT system is reported to not be operating properly. In responding to the trouble report, the technician learns that the system is set up for half-duplex operation and that the operator was sending a reply to a message, just received, when his teletypewriter started to run open. Upon returning the control unit selector switch to the "FS REC" position, the teletypewriter locked up normally with a "steady mark" input.

The described trouble symptom is confirmed when the technician places the control unit selector switch in the "FS SEND" position and the teletypewriter again starts running open. The technician, in observing and recognizing the significance of this abnormal indication, has completed Step 1 of the troubleshooting procedure.

The fact that the system appears to function properly for reception is a symptom elaboration (Step 2) in that it helps define the nature and extent of the problem at hand. Additional elaboration would also be provided by checking the loop current indication, for the appropriate (LTP SEND) circuit, at the teletype patch panel and, if possible, by crosspatching the malfunctioning LTP into another loop and/or another LTP into the loop concerned with the problem.

In all probability, these particular checks will provide all the symptom elaboration that is directly pertinent to the hypothetical problem described. If a different problem and/or system were involved, the technician would undoubtedly find other checks to be more relevant. Such checks, when performed in a logical manner, will provide a comprehensive profile of any system malfunction.

6. Thus equipped with the information obtained in Steps 1 and 2, the technician is able to proceed into Step 3 and, through a process of elimination, make an educated guess as to those equipments that are possibly at fault. To accomplish this, the technician must know how the system operates and the functional relationship of the equipments involved. Based on this knowledge, the technician will find the nature of the problem, itself, will normally allow certain equipments to be logically eliminated as possible sources of trouble. Additional equipments may also be eliminated by virtue of their front panel indications.

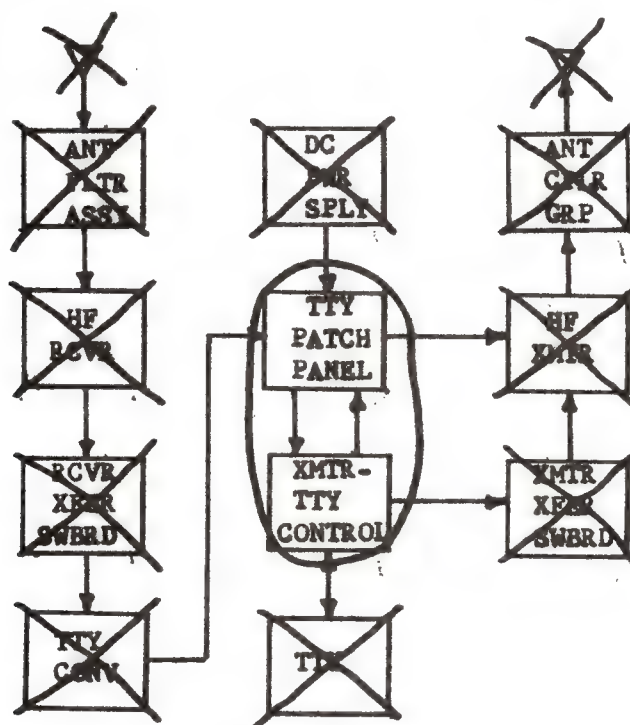
An example of this mental procedure, and how it's used to logically determine the most probable areas of trouble in Step 3, can be shown by returning to the hypothetical problem just described.

The technician should have recognized, from the first trouble symptom observed in Step 1, that the trouble is in the DC Loop to the teletypewriter. Based only on this determination, certain equipments may be logically eliminated as having anything to do with the problem. These

include, on the receive side, the antenna, antenna filter assembly, receiver and receiver transfer switchboard. On the transmit side, the antenna, antenna coupler group and transmitter transfer switchboard are also logically eliminated.

Since the DC power supply and teletypewriter are common to both the send and receive DC Loops, they, as well as the teletype converter, are next eliminated by virtue of the system functioning normally for reception (Step 2 elaboration). The problem area is thus confined to those units in the send loop that haven't yet been eliminated. These include the control unit, patch panel and transmitter. Any further reduction of the problem area requires that hypothetical indications be assigned to those other checks previously described for symptom elaboration.

Assume that the technician observed a zero loop current indication at the teletype patch panel while making front panel checks in Step 2. In following this by patching the faulty LTP into another loop, the technician observed that the original (bad) loop indication became near-normal but that the other (patched into) loop then indicated no current.



These indications, when properly analyzed with the aid of appropriate technical references, logically eliminate the transmitter, as a possible source of trouble, leaving only the teletype patch panel and control unit as suspects.

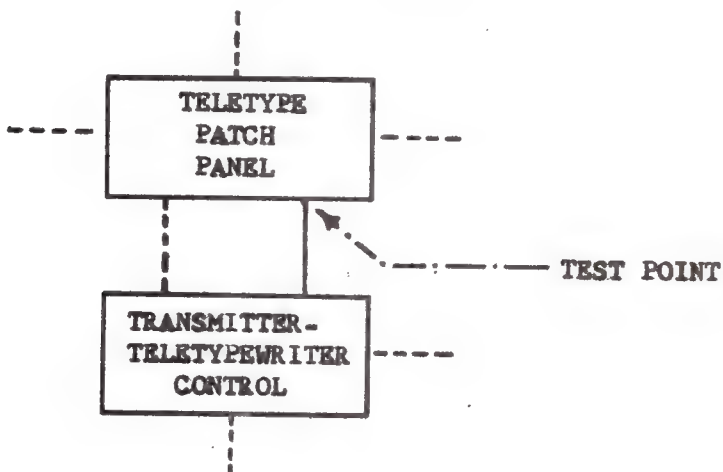
Thus, having confined the trouble to as small a functional area as is possible through front panel observations and deductive reasoning, Step 3 is completed for the hypothetical problem. More often than not, the completion of Step 3 by such an analytical process will result in the trouble being confined to only a small functional area in even complex system malfunctions.

7. The fourth step requires that the problem area be further localized to only one of the equipments determined to be possibly at fault in Step 3. If, in completing Step 3, the problem is already localized to only one equipment, Step 4 may be omitted. On the other hand, if more than one equipment is still a logical suspect, it will be necessary to determine which one is actually faulty in this step.

There are no hard and fast rules for determining which of several possible faulty equipments should be tested (or verified) first. For the most part, such a determination is usually based on which equipment is the most probable suspect and/or the least difficult to perform the necessary test on.

After selecting the order in which the tests are to be performed, the technician proceeds to verify the actual status of the suspected equipments. Normally only a suspected output and/or given input is checked using test points obtained from appropriate technical references.

As an example, from previous findings in the hypothetical problem, it can be seen that only one test need be performed to determine whether the patch panel or the control unit is actually at fault. Whether the test is performed at the appropriate LTP SEND terminals of the patch panel, or the FS SEND terminals of the control unit, is not important since the same conclusion should be reached in either case.



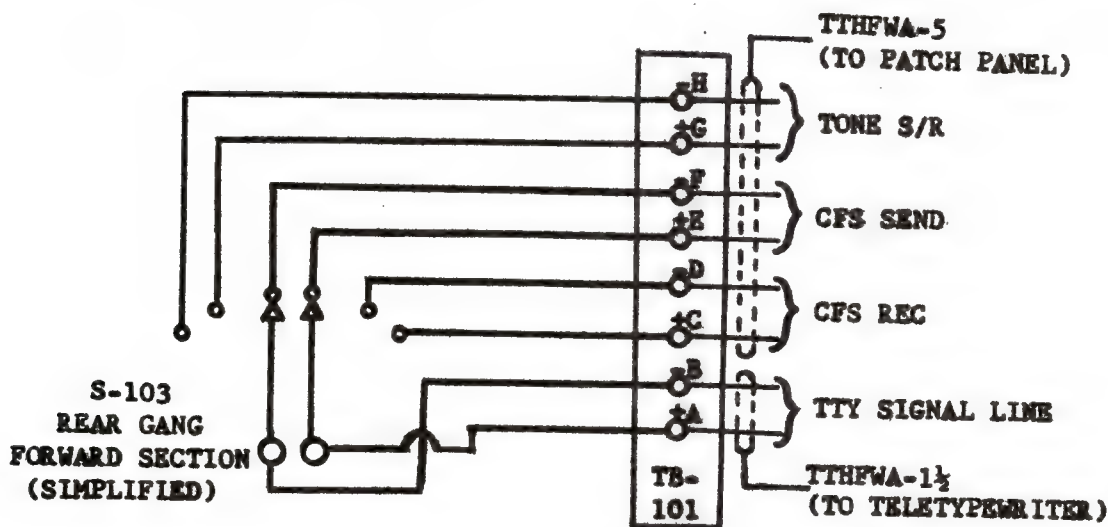
Assume that in this particular situation the technician decided to take a voltage check across the appropriate LTP SEND terminals at the teletype patch panel and, in so doing, measured the proper voltage. He may thus logically assume the control unit at the LTP to be faulty and proceed to Step 5.

8. In Step 5, the technician should perform whatever tests are appropriate to systematically isolate the defective circuit stage within the equipment that's been determined to be malfunctioning. The number of checks required to isolate the defective stage depends primarily on the complexity of the equipment involved.

Several systematic checks would undoubtedly be required in order to isolate the defective circuit in fairly complex equipment, such as a receiver or teletype converter. When a piece of multi-unit prime equipment, such as a transmitter, is involved, it may even be necessary to initiate a separate six-step procedure in order to isolate the problem to an internal circuit stage.

On the other hand, when a very simple piece of equipment is involved, such as the control unit in the hypothetical problem, only a couple of checks may be required to isolate (or verify) the defective circuit.

The most logical check to take, for the problem at hand, would be a voltage measurement across the FS SEND terminals inside the control unit. No additional check need be taken across the teletype signal line terminals since previous findings have already determined that no voltage is present, at this point, when the switch is in the FS SEND position.



Assuming that the proper voltage is measured across the FS SEND terminals, the technician should logically conclude that the switching circuitry is, in fact, defective. With the faulty circuit thus definitely isolated, Step 5 is completed.

9. In the sixth and final step, the technician proceeds to systematically isolate the defective component that is causing the identified circuit to malfunction. This is normally accomplished through a logical application of voltage and/or resistance measurements. The exact determination of what checks would be the most effective, in a given situation, depends on the type of circuit involved.

For example, the technician in the hypothetical problem would probably deenergize all power to the control unit and employ only resistance checks, since a relatively simple switching circuit is involved. In all probability, such checks would disclose either a faulty wiring connection or a defective wafer contact on the switch.

A failure analysis should be conducted, as a part of Step 6, as soon as the defective component has been isolated. This is very important lest the isolated component is either not the cause of the original problem, in any way, or it has a companion defect in a cause and effect situation. If neither condition exists, a short study of the failure will logically prove the defect to be both singular in nature and accountable for every observed symptom of the system malfunction. Such an analysis, when conducted properly, allows the technician to determine whether correcting the isolated defect will, in fact, enable the system to be restored to full operation.

10. Although there's always the possibility that a given system malfunction is caused by a defective interconnection between two of the equipments being used, such a situation should not be anticipated until systematic testing proves that it exists. For all practical purposes, such a problem is no different than a faulty interconnection between two functional units of an equipment. When a defective interconnection does exist, it will usually be logically revealed in either Step 5 or 6 of the troubleshooting procedure.

ASSIGNMENT SHEET 4-1-1A

HF CW TELEGRAPHY COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This assignment sheet contains a reading assignment followed by Self-Study items which will help you evaluate your understanding of CW Communications Systems.

B. REFERENCES:

1. INFORMATION SHEET 4-1-1I
2. INFORMATION SHEET 4-1-2I
3. INFORMATION SHEET 4-1-3I
4. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK.

C. READING ASSIGNMENT:

1. Reference 1.
2. Reference 2.
3. Reference 3.
4. Reference 4, Chapter 5, Introduction through Paragraph 5.4.A., Page(s) 36-46.

D. SELF STUDY ITEMS:

1. Briefly state the reasons for limiting "POWER OUT" of any transmitter to only that power which is required to complete a communications link. To keep from overpowering the receiver at the other end of the link which would produce distortion. It also ~~sa~~ increases XMITTR life expectancy.
2. List two advantages of using an antenna filter assembly/multi-coupler, such as the AN/SRA-12. Allows more receivers and XMITRS to use the same Antennas. And also allows less Antennas to be used.

3. Briefly define the term "INTERMODULATION".

The effecting of one unit by ~~another~~
another when using an ANT. Coupler.

4. List two steps that might be taken to reduce the likelihood of encountering intermodulation problems in shipboard receivers.

Space The Frags Used Far enough apart
and Tune The CKTS For Peak Performance.

5. Which of the following is part of a CW Communication System?

LOP
LRS
LTP

What units are situated at that site?

The receiver And The Telegraph Key Control Panel

6. How many frequencies are required for full-duplex operation?

Two

7. CW communications employs full-duplex/half-duplex/simplex operation.

8. Reference 1, "Figure 1".

List the equipments, by nomenclature, that could be used to set-up a Simplex HF CW Telegraphy Circuit.

SB 315/U Control Panel Telegraph Key

SB 988/SRT XMTTR Transfer Switchboard

AN/URT Radio XMTTR

AN/URA-38 ANT Coupler.

ASSIGNMENT SHEET 4-1-1A

9. Which two units are "hardwired" into the audio output of the receiver?

Receiver Transfer Switchboard
Receiver JACK box.

Why is this done?

So the operator CAN select who hears his transmissions + so he can hear them.

10. Which frequencies (high/low) provide the best HF communications during the day?

Why?

less Attenuation by the atmosphere.

ASSIGNMENT SHEET 4-1-2A

HF-SSB TELEPHONY COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This assignment sheet contains a reading assignment followed by Self-Study items which will help you evaluate your understanding of HF-SSB Voice Communications Systems.

B. REFERENCES:

1. INFORMATION SHEET 4-1-4I.
2. NAVSHIPS 0967-307-7010, SSB COMMUNICATION.

C. READING ASSIGNMENT:

1. Reference 1.
2. Reference 2, Chapter 2, Introduction through Paragraph 2.2.D., Page(s) 31-38

D. SELF STUDY ITEMS:

1. Describe the results of overmodulating a Voice SSB Transmitter in terms of:

a. Own-Ship communications

Power out would decrease due to the Amplifications of distortion.

b. Distant receiving station

He would received degraded Communications.

2. How long should synthesized equipments be left in stand-by operation before "on the air" operation is attempted? until the equipments reach operating Temp Why? So that the osc. will be at a stable state, eliminating drift of the oscillations.

ASSIGNMENT SHEET 4-1-2A

3. An AN/URC-32 transceiver has a dial reading of 4.094MHz and is being operated in USB/Telephony. What is the center of emission?
4. State the approximate attenuation in DB of an SSB signal for the following situation: Received signal at 5.000MHz. Receiver set for reception of a signal at 5.002MHz. _____ DB
5. An SB-973/SRR Receiver Transfer Switchboard is hardwired to 3 _____ receiver outputs and 10 remote positions.
6. List the functions provided by a remote phone unit.

start + stop of XMITR.
To Key XMITR in Phone, CW
indicates Carrier + Pwr on.
Allows sideTone at remote Phone unit.

UHF DSB AM TELEPHONY COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This assignment sheet contains a reading assignment followed by Self-Study items which will help you evaluate your understanding of UHF Voice Communications Systems.

B. REFERENCE:

1. INFORMATION SHEET 4-1-5I.

C. READING ASSIGNMENT:

1. Reference 1.

D. SELF STUDY ITEMS:

1. State two reasons why UHF Voice Communications Systems enjoy wide use in the Navy.

line of sight
high degree of reliability.

2. As a receiver adjustment, audio output (Line) level should always be adjusted to a (circle one) low/high level to prevent _____

Cross Talk.

ASSIGNMENT SHEET 4-1-4A

UHF TO HF VOX RELAY COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This assignment sheet contains a reading assignment followed by Self-Study items which will help you evaluate your understanding of UHF to HF VOX Relay Communication System.

B. REFERENCES:

1. INFORMATION SHEET 4-1-6I
2. NAVSHIPS 0967-307-7010, SSB COMMUNICATIONS.

C. READING ASSIGNMENT:

1. Reference 1.
2. Reference 2, Chapter 2.4.a., Pages 66-67.

D. SELF STUDY ITEMS:

1. A VOX Relay Unit (C-4621) provides Keying and modulation to a transmitter.
2. It is not possible to use a VOX Relay Unit to drive a frequency shift keyer, or the FSK unit of a transmitter. Why? _____.

The vox only works on Audio. The FSK would tend to always have the vox keyed giving a steady output.

HALF-DUPLEX HF-SSB
AFTS RATT COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This assignment sheet provides self-study items to help further your understanding of Half-Duplex, HF-SSB AFTS RATT SYSTEMS.

B. REFERENCES:

1. INFORMATION SHEET 4-1-7I
2. NAVSHIPS 0967-307-7010, SINGLE SIDEBAND COMMUNICATIONS
3. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK

C. READING ASSIGNMENT:

1. Reference 1, Half-Duplex HF-SSB, AFTS RATT
2. Reference 2, Section 2.5, Page 44, Paragraph A, B, C Single Channel Radio Teletype with SSB.
3. Reference 2, Section 2.6, Page 55, Paragraph A, Telegraphic Signal Distortions
4. Reference 3, Appendix C, Page 70, Paragraph C-1, C-2
5. Reference 3, Section 4.0 through 4.2, Page 17

D. SELF-STUDY ITEMS:

1. Transmissions take place (circle one) simultaneously/non-simultaneously between parties of a Half-Duplex circuit operation.
2. With an RFCS system, the Mark/Space signals shift (across/on one side of) Across the carrier.
3. List the equipments you have studied in this school which use RFCS or AFTS transmission.

WRC - 32

~~A-396~~

~~4051~~

ASSIGNMENT SHEET 4-1-5A

4. Provided a circuit designator of .98A7J and an assigned frequency of 5.745 MHz list:

Type of emission: RATT

Types of transmitters you could use: URT/23 or URC-32

Types of receivers you could use: R390 or 1051

Dial frequency of transmitter:

Dial frequency of receiver: 5.745 MHz

Can either sideband be used? yes. If so, why?

because the intelligence will be the same for either

If not, why?

List ancillary equipment required for complete system:

TTY Printer	XMITR Switchboard
TTY Transmitter Cont.	HF SSB XMITR
TTY Patch Panel	ANT. Coupler Group
TTY Conv.	(DC Loop Pwr. Supply)
Rec Switchboard	
HF SSB Rec.	
ANT Filter Assembly	

5. What type of distortion is present if the mark baud lengths are longer in duration than the space bauds? What would be the first check to make in locating the malfunction?

M-MTD bias. (marking bias)

check on the SEC-1

6. What is a character error?

The misspelling of a letter or figure.
due to component values in system

7. What mode provides the best reception of single channel RATT in the R-1051/URR receiver? Why? ~~USB~~ USB because the

Audio Tones are XMITED USB.

ASSIGNMENT SHEET 4-1-5A

8. Why is the bandwidth switch on the R-390/URR receiver placed in the 2Kc position for AFTS RATT operation?

That's The Bandwidth That will Pass
The AFTS Freq.

9. An AN/SRT-15 transmitter tuned to 15.754 MHz is being employed for a (AFTS/RFCS) 15.754 single channel RATT circuit. What dial frequency will the receiving end of the circuit use if he is using a R-1051/URR receiver? Why?

The same because its already
figured in his comm. plan.

10. What functions are performed by the C-1004/SG in an HF single channel RATT system.

Carrier on. of XmitR. (Gnd To Key)
Rec. on.

Remote Control of XmitR.

ASSIGNMENT SHEET 4-1-6A

HF-SSB AFTS MULTI-CHANNEL
RATT COMMUNICATIONS SYSTEM

A. INTRODUCTION:

1. This assignment sheet provides self-study items to help further your understanding of Half-Duplex, High Frequency, Single Sideband, Audio Frequency Tone Shift Radio Teletype Systems.

B. REFERENCES:

1. INFORMATION SHEET 4-1-8I.
2. NAVSHIPS 0967-307-7010, SSB COMMUNICATIONS.
3. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK.

C. READING ASSIGNMENT:

1. Reference 1.
2. Reference 2, Chapter 2.6., Page 52-61.
3. Reference 3, Chapter 5.4., Paragraph A through F.

D. SELF-STUDY ITEMS:

1. In reference to a multi-channel transmission state the effect of using the "blocking" or "idling" mode of operation in terms of advantages or disadvantages.

*The Advantages are it overcomes
slow fading, weak signals or noise.*

2. A normal watt meter reading on a 1KW P.E.P. transmitter with an input tone package of 4 tone pairs would be 250 watts.

3. List the advantages of using multi-channel transmissions.

More information in a small spectrum of freq.

4. Problem: In response to a trouble call, an ET finds the following situation. The radioman states that on the MUX-Broadcast Channel-1 information is absent and Channel-2 information appears on the teleprinter that normally has Channel-1 information on it. The RM has contacted other ships in the area, and they are not experiencing any trouble with the broadcast. As an interim measure, the RM states that he has readjusted the R-390 and the problem remains. What is wrong?

NOTE: Audio frequency input levels to transmitters are an extremely important consideration in prevention of EMI, especially so in SSB Multi-Channel applications. Unless input audio and output transmitted power levels are accurately set, the PA of the transmitter can be driven into the non-linear portion of its operating curve thus generating many harmonics and distorting the output to the point of unintelligibility, (over-modulation).

5. In an 8 channel AN/UCC-1D(V) configuration; all channel levels and composite tone level are set for zero dbm output. What will happen to the output level if 4 channels are 'idled'? even mod, 6 channels "idled"/ even mod, 7 channels "idled"? over modulation. What causes this?

The power from the XMIT. overdrives the remaining signal.

6. What would be the effect on the output signal, of the transmitter, if the input AF tone level decreased by 6 dbm? Explain.

would decrease because there would be almost nothing to XMIT left.

ASSIGNMENT SHEET 4-1-6A

7. Why is frequency accuracy so essential to good HF-SSB AFTS Multi-Channel RATT? Because The VCC-1 can only have a max. of 5 cycles shift. And it will print on the printer garbled.

8. What measure is taken to ensure frequency accuracy in an HF-SSB MUX transmission? Use of an external Freq standard such as the VRA 9 or 10.

UHF AFTS RATT
COMMUNICATION SYSTEM

A. INTRODUCTION:

1. This assignment sheet provides self study items to further your knowledge of ULTRA High Frequency Radio Teletype Communication Systems.

B. REFERENCES:

1. INFORMATION SHEET 4-1-91.
2. NAVSHIPS 0967-307-7010, SINGLE SIDEBAND COMMUNICATIONS.
3. NAVSHIPS 0967-308-0010, EMISSIONS AND BANDWIDTH HANDBOOK.

C. READING ASSIGNMENT:

1. Reference 1
2. Reference 2, Section 4.2., Page 19, Table 1.
3. Reference 3, Section 2.9., Page 68, Paragraph C.

D. SELF STUDY ITEMS:

1. Why is the squelch control adjustment, on the receiver, so important in this system?

Because receiver noise can key
The SGC-1 putting it into Rec From
a STBY condition.

2. List the equipment required in a full-duplex UHF AFTS RATT System, by number required and type.

2 Receivers UHF

2 XMTRS UHF

2 SGC-1

Rec. Transfer Switchboard

XMTR " "

TTY Patch Panel

TTY machine

XMTR Control Unit

Dc Pow Supply For 1 amp

ASSIGNMENT SHEET 4-1-7A

3. A Half-Duplex UHF AFTS RATT System has been set-up using:

TRANSMIT - TELETYPE MACHINE
C-1004A/UG
SB-1203/UG
DC POWER SUPPLY
AN/SGC-1
TRANSMITTER TRANSFER SWITCHBOARD
TED-9
AS-390 ANTENNA

RECEIVE - AS-390 ANTENNA
AN/SRC-21
RECEIVER TRANSFER SWITCHBOARD
AN/URA-17
DC POWER SUPPLY
SB-1203/UG
C-1004A/UG
TELETYPE MACHINE

Is one way communication possible using this system? Explain.

Yes, Just Put SGC-1 into either Xmit or Rec.

4. In what position is the function switch on the C-1004A/UG for a Half-Duplex system using an AN/SGC-1 terminal set? Why?

Tone S/R because this allows the AN/SGC-1 to ground the Keyline instead of C1004A/SG

5. What equipment keys the transmitter in this system?

The SGC-1

ASSIGNMENT SHEET 4-1-7A

6. Is full-duplex operation possible using only one AN/SGC-1 tone terminal? ~~YES~~ NO. Explain:

Because communications is in both directions simultaneously & the AN/SGC-1 can only handle one direction at a time.

7. What type of modulation is employed for UHF RATT transmissions.

AFTS

ASSIGNMENT SHEET 4-2-1A

SYSTEM BLUEPRINTS

A. INTRODUCTION:

1. This assignment sheet provides self study items to aid in a self evaluation of your ability to read and interpret system blueprints.

B. READING ASSIGNMENT:

1. INFORMATION SHEET 4-2-1I, SYSTEM BLUEPRINTS

C. SELF STUDY ITEMS:

1. Which type of blueprint would show the location of the antennas on a ship?
** Isometric wiring diagram.*
2. The DC Loop for one of the teletype machines is open. In order to isolate the problem to a specific equipment in the DC Loop, it will be necessary to obtain a blueprint showing which equipments are in the DC Loop. Which types of blueprints contain this information?
Elementary wiring diagram. Block diagram
3. Name the two places on a blueprint where a revision would be indicated.
*Upper right hand corner in the revision block.
Also in the Title Block.*
4. As an electronics technician, you are installing a new transceiver aboard your ship. Which segregation letter and system designation letters would you assign to the cable from the antenna to the transceiver?
RS-RA
5. You are installing the only teletype machine aboard your ship. The first cable in the system is from the teletype machine to the transmitter control unit. What identification number would be assigned to this cable?
IR-RT
6. Which cable listed below contains six conductors?
 - a. TTRSA-6
 - b. DHFR-6
 - c. SSF-6
 - d. MCOS-6

SYSTEMS MAINTENANCE

A. INTRODUCTION:

1. This assignment sheet provides a Self-Study exercise on Systems Maintenance Techniques and Procedures.

B. READING ASSIGNMENT:

1. Information Sheet 4-2-2I.

C. SELF-STUDY ITEMS:

1. The application of scheduled PMS checks on individual equipments (does/does not) does contribute to systems reliability.

2. Briefly describe Systems Readiness Tests (SRT's) in terms of:

- a. What they are used for by maintenance personnel.

To determine operational status of ships equipment

- b. How they are scheduled for accomplishment.

Usually just before getting under way.

- c. How and why they are customized to fit the needs of a particular installation.

They are customized to fit a

particular piece of equipment.

There is a blank area on the card to do this.

3. The six-step troubleshooting procedure may be effectively used for isolating the defect within either a system or an equipment.

ASSIGNMENT SHEET 4-2-2A

4. Why should the technician check with the operator when responding to a trouble report. Because he works around the equipment And may have noticed something that can't be reduplicated.
5. Briefly describe what is accomplished in each step of the six-step troubleshooting procedure.
- a. Step 1: recognition - recognize your Trouble.
 - b. Step 2: localize trouble - using Panel indications Further isolate the Problem.
 - c. Step 3: make An educated guess at Faulty equipment.
 - d. Step 4: localize further
 - e. Step 5: isolate defective CKT or ~~part~~ using Test equip. ect
 - f. Step 6: isolate defective Part with E+R measurements + Fix.

ASSIGNMENT SHEET 4-2-2A

6. Refer to the hypothetical problem described in Information Sheet 4-2-2I.
- a. What would have been the technician's next step had he found, in Step 2, that the problem stemmed from improper patching at the patch panel?
- b. What conclusion would be indicated if, in Step 5, the technician had measured no voltage across the FS SEND terminals in the control unit?
7. A failure analysis should always be conducted as a part of Step 6 (before/after) AFTER corrective action is taken. Why?

Because you may fix one
Problem + still have another

SIMPLEX HF CW MANUAL MORSE TELEGRAPHY COMMUNICATIONS SYSTEMS

A. INTRODUCTION:

1. This job sheet has been prepared to assist you in the accomplishment of learning objective 1.a.(1), of Topic 1.

B. EQUIPMENT:

1. ANTENNA FILTER/PATCH ASSEMBLY
2. HF RECEIVER
3. RECEIVER JACK BOX
4. CW KEY PANEL
5. TRANSMITTER TRANSFER SWITCHBOARD
6. HF TRANSCEIVER
7. ANTENNA COUPLER GROUP
8. HEAD PHONES

NOTES: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-3I, HF CW SYSTEM.
2. Technical manuals for those equipments listed on Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information;

a. CKT DESIGNATOR	<u>1.1A1</u>
b. FREQUENCY	<u>8.048 MHz</u>
c. MODE OF OPERATION	<u>CW (1KHZ)</u>
d. TRANSMITTER	<u>URT-23</u>
e. RECEIVER	<u>#2 R-390</u>
f. REMOTE(s)	<u>LOP-1</u>
g. REMARKS <u>Simplex operation.</u>	

NOTE: EMI poses a serious threat to RF compatibility on all ships. A major contributor to this problem is over confidence on the part of technicians and operators when setting-up various electronic units, particularly transmitters. Most "short cut" procedures tend to inadvertently omit some of the critical front panel checks and adjustments. The only remedy to this problem is to insure that each time a transmitter is placed on the line, careful attention is given to the correct procedure as outlined in the operators section of the appropriate technical manual.

CHECK OFF

2. Energize, tune and adjust transmitter following procedures outlined in the technical manual for the indicated mode of operation. _____

NOTE: Do not exceed the RF output power level established for use in this laboratory.

3. At the transmitter transfer switchboard, switch the transmitter to the indicated LOP for remote operation. _____
4. Patch receiving antenna to the input jack of the antenna filter assembly. _____
5. Select the correct filter output of the antenna filter assembly and patch it to the receiver used in this system. _____
6. Connect head phones to the jack box associated with the receiver in use. _____
7. Energize, tune and adjust the receiver following procedures outlined in the technical manual for the indicated mode of operation. _____
8. At the LOP, key the transmitter. _____
9. While listening to own-ship transmission, adjust the BFO on the receiver for a comfortable tone. _____
10. Establish a communications link with "other ship." _____
11. List those concepts of RF compatibility which you paid particular attention to while setting-up this system. _____

12. When you have completed this Job Sheet, have the instructor check and initial. _____

SIMPLEX HF SSB TELEPHONY COMMUNICATIONS SYSTEM

A. INTRODUCTION:

This job sheet has been prepared to assist you in accomplishing learning objective 1.a.(2), of Topic 1.

B. EQUIPMENT:

1. HF SSB TRANSCEIVER
2. RECEIVER TRANSFER SWITCHBOARD
3. SPEAKER AMPLIFIER
4. REMOTE PHONE UNIT
5. TRANSMITTER TRANSFER SWITCHBOARD
6. TRANSMIT ANTENNA COUPLER GROUP

NOTE: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-4I.
2. Technical manuals for those equipments listed on Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information;

- a. CKT. DESIGNATOR ... 2 3A3 J
- b. FREQUENCY ... 14.870 MHz
- c. MODE OF OPERATION SSB/USB .. VOICE
- d. TRANSMITTER ... # 5 AN/URC -32
- e. RECEIVER ... # 1 R-1051
- f. REMOTE(s) ... LOP-1
- g. REMARKS _____

CHECK OFF

-



7

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

1

JOB SHEET 4-1-3J

SIMPLEX UHF DSB AM TELEPHONY COMMUNICATIONS SYSTEM

A. INTRODUCTION:

This job sheet has been prepared to assist you in accomplishing learning objective 1.a.(2), of Topic 1.

B. EQUIPMENT:

1. UHF TRANSCEIVER
2. RECEIVER TRANSFER SWITCHBOARD
3. SPEAKER AMPLIFIER
4. REMOTE PHONE UNIT
5. TRANSMITTER TRANSFER SWITCHBOARD

NOTE: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-5I.
2. Technical manuals for those equipments listed on Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information;

- a. CKT. DESIGNATOR _____
- b. FREQUENCY _____
- c. MODE OF OPERATION _____
- d. TRANSMITTER _____
- e. RECEIVER _____
- f. REMOTE(s) _____
- g. REMARKS _____

JOB SHEET 4-1-3J

CHECK OFF

2. Energize, tune and adjust transceiver following procedures outlined in the technical manual for the indicated mode of operation. _____
3. At the transmitter transfer switchboard, switch the transmitter to the remote position indicated. _____
4. At the receiver transfer switchboard, switch the receiver to the remote position indicated. _____
5. Adjust the volume of the speaker amplifier for a comfortable listening level. _____
6. Adjust the earphone volume control on the remote phone unit for a comfortable listening level. _____
7. Establish telephony (voice) communications with "other ship." _____
8. List those concepts of RF compatibility which you paid particular attention to while setting-up this system. _____

9. When you have completed this Job Sheet, have the instructor check and initial. _____

SIMPLEX VOX RELAY UHF DSB AM
TELEPHONY TO HF SSB TELEPHONY

A. INTRODUCTION:

This job sheet has been prepared to assist you in accomplishing learning objective 1.a.(4), of Topic 1.

B. EQUIPMENT:

1. UHF RECEIVER
2. RECEIVER TRANSFER SWITCHBOARD
3. VOX RELAY CONTROL UNIT
4. TRANSMITTER TRANSFER SWITCHBOARD
5. HF SSB TRANSMITTER
6. TRANSMIT ANTENNA COUPLER GROUP

NOTE: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-6I.
2. Technical manuals for those equipments listed on Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information;

a. CKT. DESIGNATOR	<u>4343-613</u>
b. FREQUENCY	<u>15 MHz to 300 MHz</u>
c. MODE OF OPERATION	<u>VOX</u>
d. TRANSMITTER	<u>Ted</u>
e. RECEIVER	<u>Red</u>
f. REMOTE(s)	<u>C4621</u>
g. REMARKS _____	

JOB SHEET 4-1-4J

CHECK OFF

2. Energize, tune and adjust UHF receiver following procedures outlined in the technical manual for the indicated mode of operation. X
3. At the receiver transfer switchboard, switch the receiver to the remote indicated. X
4. Energize and set-up the VOX relay control unit following procedures outlined in the technical manual. X

NOTE: This unit requires an audio input from the receiver to correctly set the modulation level.

5. At the transmitter transfer switchboard, switch the transmitter to the VOX relay control unit. X
6. Energize, tune and adjust the transmitter following procedures outlined in the technical manual for the indicated mode of operation. X
7. Place transmitter into remote operation and begin VOX relay. X
8. List those concepts of RF compatibility which you paid particular attention to while setting-up this system. _____

9. When you have completed this Job Sheet, have the instructor check and initial. X

HALF-DUPLEX HF SSB AFTS RATT
COMMUNICATIONS SYSTEM

A. INTRODUCTION:

This information sheet has been prepared to assist you in accomplishing learning objective 1.a.(5), of Topic 1.

B. EQUIPMENT:

1. RECEIVE ANTENNA FILTER/PATCH ASSEMBLY
2. HF SSB RECEIVER
3. RECEIVER TRANSFER SWITCHBOARD
4. CONVERTER/COMPARATOR GROUP
5. DC POWER SUPPLY
6. TELETYPE PATCH PANEL
7. TELETYPE MACHINE
8. TRANSMITTER CONTROL UNIT
9. TRANSMITTER TRANSFER SWITCHBOARD
10. HF SSB TRANSMITTER
11. TRANSMIT ANTENNA COUPLER GROUP

NOTE: Due to laboratory dissimilarities in equipment type the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-7I.
2. Technical manuals for those equipments listed on Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information;

- a. CKT. DESIGNATOR _____
- b. FREQUENCY _____
- c. MODE OF OPERATION _____
- d. TRANSMITTER _____
- e. RECEIVER _____
- f. REMOTE(s) _____
- g. REMARKS _____

JOB SHEET 4-1-5J

- | | <u>CHECK OFF</u> |
|--|------------------|
| 2. Energize, tune and adjust the transmitter following procedures outlined in the technical manual for the indicated mode of operation. | _____ |
| 3. At the transmitter transfer switchboard, switch the transmitter to the remote position indicated. | _____ |
| 4. Energize, tune and adjust the receiver following procedures outlined in the technical manual for the indicated mode of operation. | _____ |
| 5. At the receiver transfer switchboard, switch the receiver to the converter/comparator group. | _____ |
| 6. Energize the DC power supply. | _____ |
| 7. Energize, tune and adjust the converter/comparator group following procedures outlined in the technical manual. (This requires an input signal to the converter). | _____ |
| 8. At the teletype patch panel; | |
| a. Patch the converter to the receive loop of the indicated TTY machine. | _____ |
| b. Switch the converter's function switch to "tune." (This puts a steady mark signal on the loop). | _____ |
| c. Place the function switch of the Control Transmitter Unit to the "FS REC" position. | _____ |
| d. Energize the TTY machine. | _____ |
| e. Adjust the receive loop current on the TTY patch panel to 60 Ma. | _____ |
| f. Place the function switch of the Control Transmitter Unit to the "FS SEND" position. | _____ |
| g. Adjust the send loop current on the TTY patch to 60 Ma. | _____ |
| h. Place the function switch on the converter to the "SINGLE" position. | _____ |
| 9. Establish communications with "other ship." | _____ |

JOB SHEET 4-1-5J

10. List those concepts of RF compatibility to which you paid particular attention while setting-up this system.

11. When you have completed this Job Sheet, have the instructor check and initial.

MULTIPLEX HF SSB AFTS RATT
COMMUNICATIONS SYSTEM

A. INTRODUCTION:

This job sheet has been prepared to assist you in accomplishing learning objective 1.a.(6), of Topic 1.

B. EQUIPMENT:

1. RECEIVE ANTENNA FILTER/PATCH ASSEMBLY
2. HF SSB RECEIVER
3. RECEIVER TRANSFER SWITCHBOARD
4. TELEGRAPH TERMINAL SET (Multiple-Channel)
5. DC POWER SUPPLY
6. TELETYPE PATCH PANEL
7. RED/BLACK SWITCH (Simulator)
8. TELETYPE MACHINE
9. TRANSMITTER CONTROL UNIT
10. TRANSMITTER TRANSFER SWITCHBOARD
11. HF SSB TRANSMITTER
12. TRANSMIT ANTENNA COUPLER GROUP
13. FREQUENCY STANDARD
14. FREQUENCY STANDARD PATCH PANEL

NOTE: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-8I.
2. Technical manuals for those equipments listed on the Comm Plan,

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information,

- a. CKT. DESIGNATOR _____
- b. FREQUENCY _____
- c. MODE OF OPERATION _____
- d. TRANSMITTER _____

e. RECEIVER _____

f. REMOTE(s) _____

g. REMARKS _____

- | | <u>CHECK OFF</u> |
|--|------------------|
| 2. At the frequency standard patch panel, patch the required standard frequency to the transmitter and receiver in this system. | _____ |
| 3. At the antenna filter/patch assembly, select an antenna and patch it to the filter assembly input. | _____ |
| 4. At the antenna filter/patch assembly, patch the correct filter output to the indicated receiver. | _____ |
| 5. Energize, tune and adjust the receiver following procedures outlined in the technical manual for the indicated mode of operation. | _____ |
| 6. At the receiver transfer switchboard, switch the receiver to the MUX telegraph terminal set. | _____ |
| 7. At the MUX terminal set, insure that the following conditions exist. | _____ |

a. In the converter cabinet, the first two converters must meet the following criteria.

	POSITION	DIVERSITY	REC.	NORMAL/REVERSE
(1)	1785 cps	2 div	Rec A	Normal
(2)	425 cps	2 div	Rec A	Normal

b. In the keyer cabinet, the first two keyers must meet the following criteria.

	POSITION	DIVERSITY	NORMAL/REVERSE
(1)	1785 cps	2 div	Normal
(2)	425 cps	2 div	Normal

8. Energize the receive MUX terminal. _____
9. Patch the MUX channel-1 receive loop to the indicated TTY machine at the TTY patch panel. _____
10. Place the function switch of the transmitter control unit to the "FS Rec." position. _____
11. Place the function switch of the Red/Black switch to the "Black" position. _____
12. Energize DC power supply. _____
13. Energize the receive TTY machine. _____
14. While receiving a "Mark" signal, adjust loop current to 60 Ma. _____

NOTE: This completes the receive side of this full-duplex system. Referring to the block diagram of this system in Information Sheet 4-1-8I, it can be seen that an additional 3 receive information loops could be utilized. It is only the lack of equipment (3 additional Rec TTY machines and 3 additional send TTY machines) that prevents us from demonstrating this feature.

15. Energize, tune and adjust transmitter following procedure outlined in the Technical Manual for the indicated mode of operation. Do not leave the transmitter keyed. _____
16. At the TTY patch panel, patch the MUX terminal to the send TTY machine. _____
17. At the transmitter control unit, switch the function selector to "FS Send." _____
18. Switch the Red/Black switch to "Black." _____
19. Energize the send TTY machine. _____
20. At the TTY patch panel, adjust the send loop current to 60 Ma. _____

JOB SHEET 4-1-6J

21. Energize, and adjust the (MUX) terminal set following procedures outlined in the Technical Manual. _____
22. At the transmitter transfer switchboard, switch the transmitter to the position indicated. _____
23. At the transmitter, place the local key in a locked position and recheck for proper operation. _____
24. Establish (Full-Duplex) RATT communications with "other ship." _____
25. List those concepts of RF compatibility which you paid particular attention to while setting-up this system.

26. When you have completed this Job Sheet, have the instructor check and initial it. _____

HALF-DUPLEX UHF DSB AFTS RATT
COMMUNICATIONS SYSTEM

A. INTRODUCTION:

This job sheet has been prepared to assist you in accomplishing learning objective 1.a.(7), of Topic 1.

B. EQUIPMENT:

1. UHF TRANSCEIVER
2. RECEIVER TRANSFER SWITCHBOARD
3. TONE TERMINAL SET (Single-Channel)
4. DC POWER SUPPLY
5. TELETYPE PATCH PANEL
6. TELETYPE MACHINE
7. TRANSMITTER CONTROL UNIT
8. TRANSMITTER TRANSFER SWITCHBOARD

NOTE: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-9I.
2. Technical manuals for those equipments listed on Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information:

- a. CKT. DESIGNATOR _____
- b. FREQUENCY _____
- c. MODE OF OPERATION _____
- d. TRANSMITTER _____

JOB SHEET 4-1-7J

e. RECEIVER _____

f. REMOTE(s) _____

g. REMARKS _____

- | | <u>CHECK OFF</u> |
|---|------------------|
| 2. Energize, tune and adjust the transceiver following procedures outlined in the technical manual for the indicated mode of operation. | _____ |
| 3. Switch the receiver audio to the tone terminal set at the receiver transfer switchboard. | _____ |
| 4. Energize the DC power supply. | |
| 5. Energize, and adjust the tone terminal set following procedures outlined in the technical manual. | _____ |
| 6. Switch the tone terminal set output to the transceiver at the transmitter transfer switchboard. | _____ |
| 7. At the TTY patch panel, patch the tone terminal set to the indicated TTY machine. | _____ |
| 8. Switch the function selector of the transmitter control unit to "Tone Send/Rec." | _____ |
| 9. Energize the TTY machine. | _____ |
| 10. Establish RATT communications with "other ship." | _____ |
| 11. List those concepts of RF compatibility which you paid particular attention to while setting-up this system. | |
| _____ | |
| _____ | |
| 12. When you have completed this Job Sheet, have the instructor check and initial. | _____ |

SIMULATED SECURE
MULTIPLEX HF SSB AFTS RATT
COMMUNICATIONS SYSTEM

A. INTRODUCTION:

This job sheet has been prepared to assist you in accomplishing learning objective 1.a.(8), of Topic 1.

B. EQUIPMENT:

1. RECEIVE ANTENNA FILTER/PATCH ASSEMBLY
2. HF SSB RECEIVER
3. RECEIVER TRANSFER SWITCHBOARD
4. TELEGRAPH TERMINAL SET (Multiple-Channel)
5. DC POWER SUPPLY
6. TELETYPE PATCH PANEL
7. RED/BLACK SWITCH (Simulator)
8. TELETYPE MACHINE
9. TRANSMITTER CONTROL UNIT
10. TRANSMITTER TRANSFER SWITCHBOARD
11. HF SSB TRANSMITTER
12. TRANSMIT ANTENNA COUPLER GROUP
13. FREQUENCY STANDARD
14. FREQUENCY STANDARD PATCH PANEL
15. ENCODER/DECODER (Simulator)
16. SECURE DC POWER SUPPLY
17. TELETYPE PATCH PANEL (Secure)

NOTE: Due to laboratory dissimilarities in equipment type, the equipments have been listed by functional requirements only. The actual equipment nomenclature will be listed on the Comm Plan.

C. REFERENCES:

1. Information Sheet 4-1-10I.
2. Technical manuals for those equipments listed on the Comm Plan.

D. JOB STEPS:

1. Consult the Comm Plan and obtain the following information.

- a. CKT. DESIGNATOR _____
- b. FREQUENCY _____
- c. MODE OF OPERATION _____
- d. TRANSMITTER _____
- e. RECEIVER _____
- f. REMOTE(s) _____
- g. REMARKS _____

- 2. At the frequency standard patch panel, patch the required standard frequency to the transmitter and receiver in this system.
- 3. At the antenna filter/patch assembly, select an antenna and patch it to the filter assembly input.
- 4. At the antenna filter/patch assembly, patch the correct filter output to the indicated receiver.
- 5. Energize, tune and adjust the receiver following procedures outlined in the technical manual for the indicated mode of operation.
- 6. At the receiver transfer switchboard, switch the receiver to the MUX telegraph terminal set.

CHECK OFF

7. At the MUX terminal set, insure that the following conditions exist.

- a. In the converter cabinet, the first two converters must meet the following criteria.

	POSITION	DIVERSITY	REC.	NORMAL/REVERSE
(1)	(1) 1785 cps	2 div	Rec A	Normal
	(2) 425 cps	2 div	Rec A	Normal

- b. In the keyer cabinet, the first two keyers must meet the following criteria.

	POSITION	DIVERSITY	NORMAL/REVERSE
(1)	1785 cps	2 div	Normal
(2)	425 cps	2 div	Normal

8. Energize the receive MUX terminal.
9. Patch the MUX channel 1 receive loop to the indicated secure device at the TTY patch panel.
10. Energize the secure device (Decoder)
11. At the "Red" TTY patch panel, patch the decoder's output to the indicated TTY machine.
12. Place the function switch of the transmitter control unit to the "FS Rec." position.
13. Place the function switch of the Red/Black switch to the "Red" position.
14. Energize DC power supply.
15. Energize the secure DC power supply.
16. Energize the receive TTY machine.
17. While receiving a "Mark" signal, adjust loop current to 60 Ma.

NOTE: This completes the receive side of this full-duplex system.

JOB SHEET 4-1-8J

18. Energize, tune and adjust transmitter following procedures outlined in the Technical Manual for the indicated mode of operation. Do not leave the transmitter keyed. _____
19. At the TTY patch panel, patch the MUX terminal to the encoder. _____
20. Energize the encoder. _____
21. At the Red TTY patch panel, patch the encoder to the send TTY machine. _____
22. At the transmitter control unit, switch the function selector to "FS Send." _____
23. Switch the Red/Black switch to "Red." _____
24. Energize the send TTY machine. _____
25. At the Red TTY patch panel, adjust the send loop current to 60 Ma. _____
26. Energize, and adjust the (MUX) terminal set following procedures outlined in the Technical Manual. _____
27. At the transmitter transfer switchboard, switch the transmitter to the remote position indicated. _____
28. At the transmitter, place the local key in a locked position and recheck for proper operation. _____
29. Establish (Full-Duplex) RATT communications with "other ship." _____
30. List those concepts of RF compatibility which you paid particular attention to while setting-up this system.

31. When you have completed this Job Sheet, have the instructor check and initial it. _____

CONDUCT SYSTEM READINESS TEST

A. INTRODUCTION:

1. This job sheet has been prepared to assist you in accomplishing learning objective 4-2-A 1.b.
2. The job steps are general in nature so as to make them applicable to any system readiness test you may be required to perform.

B. REFERENCES:

1. OPNAV Form 4700-1, MAINTENANCE REQUIREMENT CARD.
 - a. System Readiness Tests
 - (1) CT-3 R1 LF/MF/HF Comm Systems Transmitters
 - (2) CT-4 R1 Radio TTY System
 - (3) CT-7 R1 Comm Remote Systems
 - (4) CT-8 R1 UHF/VHF Comm Systems
 - (5) CT-9 R1 LF/MF/HF Comm Systems (Receiving)
2. INFORMATION SHEET 4-2-2I.

C. JOB STEPS:

1. Consult your ships weekly schedule and determine which MRC/SRT you have been assigned _____.
2. If this MRC/SRT has a related MRC/SRT, what is the MR number?
3. Perform the SRT that you have been assigned and record those indications that are referenced on the SRT in the space provided below.

4. Have the instructor check and initial. _____.

